Drawn and Engraved by S. Springsguth

The back grinding tooth of the MAMMOTH *or* MASTODON *of Ohio.* —— weight. 4 lb. 7 oz.

Published by M. A. Nattali. 1833.

ORGANIC REMAINS OF A FORMER WORLD.

AN EXAMINATION OF THE

MINERALIZED REMAINS OF THE VEGETABLES AND ANIMALS

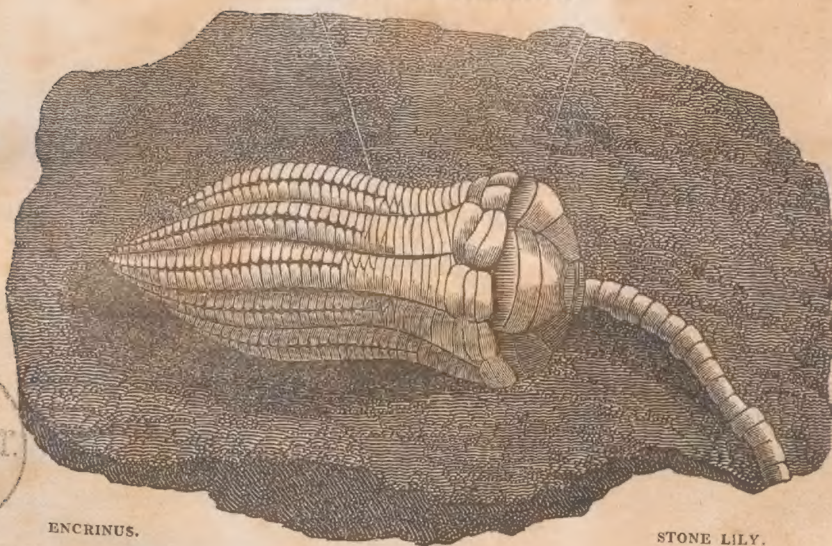
OF THE

ANTEDILUVIAN WORLD;

GENERALLY TERMED EXTRANEOUS FOSSILS.

BY JAMES PARKINSON.

IN THREE VOLUMES.



ENCRINUS. STONE LILY.

THE THIRD VOLUME;

CONTAINING

THE FOSSIL STARFISH, ECHINI, SHELLS, INSECTS, AMPHIBIA, MAMMALIA, &c.

SECOND EDITION.

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PREFACE

TO THE THIRD VOLUME.

Agreeable to the plan of this work, the important observations and discoveries of M. Lamarck and of M. Cuvier are introduced in the present volume; but it may be necessary to notice the circumstances which have occasioned the account of their labours to be extended to so considerable a length.

Excepting the *Fossilia Hantoniensia* of Solander and Brander, no really systematic arrangement of fossil shells had appeared; the classification of shells, therefore, by Lamarck, in which particular attention is paid to those in a fossil state, became highly estimable. So clear and so comprehensive is the arrangement of this naturalist, that of the numerous fossil shells which were unclassed, there are hardly any which may not now be placed under an appropriate genus. This circumstance alone, it is presumed, will warrant the having introduced into this volume the generic characters of this system.

Very few successful anatomical examinations of the fossil remains of *amphibia*, and of land animals, had been attempted before the justly celebrated Cuvier made them the subjects of his investigation: but, in consequence of the ardour with which he has availed himself

of the extraordinary opportunities which he possessed, the history of these fossils must now be chiefly formed with the materials which he has furnished. The full range of the plaster quarries, so rich in fossil bones, and the unlimited power of examining the rich cabinets of fossils which have been dragged to the National Museum, from different parts of France and of the Continent; and, above all, the opportunity of comparing these with the recent bones in the prodigious collections of skeletons, &c. in the Museum, have placed before him a rich harvest, which he has most carefully reaped. By his persevering assiduity he has accomplished the most important discoveries respecting several unknown animals which have existed in former ages of this planet. To have omitted an account of these discoveries, would have been a departure from the intention of the work; and to have extracted less than is here given, could not have been done without injurious mutilation.

From the frequency with which these invaluable labours are referred to, it would have been very difficult to have marked each reference; it has, therefore, been thought preferable to give two lists of the references to the places where the several subjects are treated of in the original works of these authors.

It is presumed, that the phenomena noticed in this work may lead to highly useful discoveries, and to the establishment of important truths. Already the mineralized remains of numerous unknown plants and animals have added facts, supplementary, as it were, but of a highly interesting nature, to the sciences of Botany and of Zoology. From the connected examination of fossils, and of the strata which contain them, much useful information may be expected to be obtained, respecting the situations in which various

useful substances may be found. Thus, the traces of vegetables generally point out the vicinity of coal, whilst the remains of land animals show that, in general, in the places in which they are found, coal can exist but at prodigious depths. It is, therefore, hoped that, in future, the circumstance of particular fossils being found in certain strata, may be more particularly attended to: and whilst noticing the localities of fossils, it is recommended to mark the stratum, as well as the name of the place, in which they are found.

The phenomena particularised in the latter part of this volume, yield some important knowledge respecting the structure of the planet which we inhabit. These facts would also supply, if it were needed, the strongest proof of the error of those who believe, that there has always been a succession something similar to what is continually observed; and that the human species have had, and will have, a uniform and infinite existence. With almost equal force will these phenomena oppose that system also, which considers the form and structure of the surface of this planet, as resulting from a regularly recurring series of similar mutations.

The loss of whole species or genera, and the late creation of others, as is assumed in this work, are circumstances which strongly militate against both these hypotheses. It must, however, be acknowledged, that some accurate inquirers have doubted whether a single species has been thus lost. Bruguiere attempted to account for this apparent extinction of several species of shell-fish, by supposing that there are many genera, and even families, which live constantly in the lowest depths of the sea. These animals, which he termed Pelagian, being entirely out of the reach of man, can only, he supposed, become known to him by the mineralized remains of

those shells, which have been left in parts over which former seas have flowed. Among these shells he places the Ammonite, the Belemnite, and the Orthoceratite; but it is expected that it will be shown in the following pages that all these shells possess a peculiar structure, which belongs to such an organization, as would have enabled those animals to raise themselves up to, and even to support themselves at, the surface of the water.

Many have been led to doubt the total extinction of some species, and the late creation of others, as circumstances which would be incompatible with the power and wisdom of the Almighty, who, they conceive, would have formed a creation so complete at first, as to have required no subsequent change. Without dwelling on the impropriety of such modes of reasoning, it must be observed, that the facts are indubitable, and afford a direct proof of the Creator of the universe continuing a superintending providence over the works of his hands. That the extinction of species may be taking place even in our days, seems to be shown by the discovery of dead shells in the island of St. Helena, differing from any known species of recent or of fossil shells. The small remaining number of some species of animals, such as the *Dodo* and the sloths, seems also to give some support to this opinion.

ORGANIC REMAINS

OF A

FORMER WORLD, &c.

LETTER I.

STAR-FISH...RARELY MINERALISED...FOSSIL SPECIES PARTICULARISED.

As we proceed upwards on the scale of creation, the star-fish, or sea-star, *Stella marina, Linckii, et Asteria, Linnæi**, is the next animal which demands our attention, as a subject of the mineral kingdom. The fossil remains of these animals are by no means so frequent as are those of many others; a circumstance which is perhaps not to be satisfactorily accounted for. The numerous species of these animals which do now exist, and the comparatively few which are found in a mineralised state, lead to the supposition, that

* The name, *Stella marina*, employed by Linck, on the authority of Pliny, is adopted, in these pages, in preference to *Asteria*, which Linnæus has used, after Hippocrates and Aristotle. The only reason for this adoption is, that the confusion will thereby be prevented, which would necessarily arise from the employment, in this place, of the word *asteria*, which oryctologists, and indeed natural historians, have generally applied to the vertebræ of the pentacrinites, as may be seen in the preceding volume.

the paucity of fossil star-fish depends, either on some circumstance in the original composition of the animal, which renders it little fit to undergo the petrifying change; or on some circumstance, in its mineral state, which prevents its preservation in its matrix, or its safe extrication from it. All these circumstances have, perhaps, some share in occasioning the scarcity of these fossils: it appears, however, to be chiefly attributable to the original conformation of the covering of the animal, which is the only part which can be preserved to us by mineralization.

The coriaceous, and even pulpy consistence, of the coverings of these animals, in a living state, plainly evinces that the mucilaginous or membranous matter bears a very large proportion to the carbonate of lime, which enters into the composition of these bodies. On the cessation of life, therefore, a speedy decomposition of this animal matter must ensue; and from a deficiency of earthy matter to support its form, the whole substance must, in general, be resolved into a shapeless mass.

The crustaceous covering of one of these animals, of a smallish size, was found to be pierced with fifteen hundred and twenty apertures, through which passed, or to which were attached, as many horny tubes; serving, according to M. Reaumur*, either as feet, or as organs through which the water received by the stomach of the animal was ejected. The anatomy of this animal, however, has not, at least to my knowledge, been pursued so far, as to determine the real use of these tubes, which seem rather to be analogous with the absorbent tubes of the echinus. For our present purpose, it is only necessary to remark, that the membranous matter connecting these tubes with the external crust, or lining the apertures through which these tubes pass, must considerably add to the quantity of animal membrane, on the predominance of which its perishable nature so much depends.

* *Observatio de Stellis marinis*, Sect. viii.

From the nature and proportion, therefore, of the constituent parts of the coriaceous crust of the animal, and its speedy resolution, by which it is prevented from passing through the several changes necessary to its mineralization, we may suppose, that the rareness of its being found in a petrified state chiefly proceeds.

The remains of several species of these animals have, however, been preserved, and chiefly in chalk and in lime-stone; and almost all of them approximate so nearly to known recent animals, as to allow of the considering them as of similar species with those which have been described by Linck and other naturalists.

The recent animals to which the fossil species appear to be referable, are:—

1. *Pentagonaster semilunatus; Linck. de Stellis marinis, Tab.* XXIII. *No.* 37; XXIV. *No.* 39 and 45. This fossil has been figured by Schultz, *Betrachtung der versteinerten, Tab.* II. *Fig.* 6, from Pirna. A chalk fossil, from the Kentish chalk-pits, in which a considerable part of this lunated star is preserved, is represented Plate I. Fig. 1. M. Walch, in Knorr's work, *Recueil des Monumens des Catastrophes, &c.* gives the figure of an impression on a flint, from New Strelitz, of a stellite of this species.

2. *Pentagonaster regularis; Linck. Tab.* XIII. *No.* 22. A fossil asterite of this species, with which I was favoured by H. H. Goodall, Esq. of the East India House, is figured Plate I. Fig. 3. This is also from the Kentish chalk-pits.

3. *Pentaceros reticulatus, Linck. Tab.* XXIII. XXIV. *No.* 36, is found fossil, in fragments, at *Chassai sur Saone*, according to Davila.

4. *Pentaceros lentiginosus, seu, Stella reticulata lentiginosa; Linck. Tab.* XLI. and XLII. I lately obtained a stellite of this species, or very nearly approaching to it, from one of the Essex chalk-pits. The specimen, though large and handsome, and possessing the general form of this animal, would not have given the idea of this particular species, perhaps, if the two rows of mamillæ, or rather bones, had

not still existed in one part of the lunated or falcated margin. Fragments of this species are sometimes found in the Isle of Sheppey.

5. *Astropecten echinatus minor; Linck. Tab.* VIII. *No.* 12. Some fragments of a stellite, of which this stella is supposed to be the analogue, is depicted in Knorr's work, Supp. Pl. VII. b. 3. I obtained, at the sale of some of the Marquis of Donegal's fossils, a most uncommonly perfect specimen resembling this species. It is imbedded on a lime-stone, of a yellow colour, and has only lost a part of one of its rays. I have not been able to learn where this fossil was found. Portions, and even complete specimens of stellites, apparently of this species, are found among the pyrites of the Isle of Sheppey. A specimen, which now lies before me, has one of its rays perfect; and has sufficient left, of the others, almost to determine that it is of this species.

6. *Stella coriacea acutangula; Linck. Tab.* IX. X. *Fig.* 19. The common yellow star-fish of Lhwydd. A petrifaction of this species was found at Malesme, in France; and is figured and described by M. Guettard, *Mem. de l'Acad. An.* 1763.

7. *Stella lumbricalis lacertosa, corpore sphærico: Linck. Tab.* II. *No.* 4. A fossil, containing a considerable portion of a stellite, resembling this species, is figured by Bourguet, *Traité des Petrifactions*, Plate LIX. No. 438. A very beautiful specimen, imbedded in chalk, apparently of this species, was sold at the sale of the Leverian Museum. To this species the small stellites seem to approximate, which are found in the fissile stones of Solenhofen and Pappenheim, and which bear so near a resemblance to spiders. One of these is depicted, Plate I. Fig. 15.

8. *Stella lumbricalis, corpore pentagono, lateribus lunatis; Linck. Tab.* XXII. *No.* 35. Three specimens of a micaceous sand-stone, from Cobourg, with several stellites, which appear to be of this species, are figured by Knorr, *Recueil des Monumens, &c. Tab.* L. 1. 23. Another specimen is also described by M. Davila, *Catal. Tome* III. *p.* 191.

9. *Stella lumbricalis, corpore sphærico tuberculoso, radiis conice productis.* Under this denomination M. Walch comprehends small

detached stelliform fossils, about the size of a lentil, which are found in St. Peter's mountain, near Maestricht. *Recueil des Monum. Tom.* II. *p.* 262. The body of this animal appears to have been of a spherical form, and large in proportion to the length of its rays, which are conical, and vary in their number, from four or five to six or nine. The body, as well as the rays, are beset with tubercles.

10. *Stella crinita, decacnemos rosacea, Linck. Tab.* XXXVII. *No.* 66, is figured as a fossil by Baier, *Oryct. Noric. Tab.* VIII. *No.* 5; and by Knorr, *Recueil des Monumens, Plate* VII. *Fig.* 6.

11. *Stella decacnemos, barbata, Linck. Tab.* XXXVII. *No.* 64, appears also to be figured as a fossil by Baier, *Monim. Rer. Petr. Tab.* VII. *No.* 2, 4, and 5; and in *Oryctogr. Noric. Tab.* VIII. *Fig.* 4.

12. *Stella crinita polycacnemos*, the *Caput Medusæ* of Linck; *Linck. Tab.* XXI. *et* XXII. Gesner, *De Petrificatis, p.* 31, mentions a fossil, which he supposes to be a fragment of this species; and of which, it appears, that fragments only have been found.

13. *Astrophyton*, of Linck; or *Caput Medusæ* of Rumphius; *Cabinet des Raretés d'Amboine, Tab.* XVI. Gesner, *De Petrificatis, p.* 31. speaks of fossil fragments of this animal having also been repeatedly found. This he repeats on the authority of Lhwydd, who names a fossil (No. 1132) of this kind, *Astropodium Ramosum;* and on that of the intelligent Rosinus, who also figures *(Prodromus, &c. Tab.* x. *Fig.* II. *No.* 1.*)* what he supposes to be a fossil of this kind. Gesner, however, did not advert to the circumstance of both Lhwydd and Rosinus having written before the period at which the pentacrinites were discovered. An inspection of the figures given by Lhwydd and by Rosinus will directly show, that the fossils which they have figured are undoubtedly parts of pentacrinites.

Mr. Knorr, *Sup. Tab.* VI. 8—17, figures various small fossil bodies, which he learned came from some part of Italy, and which he considers as belonging to the *Stellæ fissæ* of Linck; but acknowledges that, even with the microscope, he was unable to discover the

fissure, which, in the recent stella, is always observable. He thinks, therefore, that these bodies must either belong to a species of stellæ entirely unknown to us, or must be merely the casts of minute stellæ.

Plate I. Fig. 16, is a sketch of a fossil stella figured by Baier, *Moniment. Rer. Petrif. Tab.* VII. *Fig.* 6, which he considers as referable to small coriaceous pentapetalous sea-stars.

I am happy in being able to communicate the observations of the late Mr. Strange, on a minute species of stellæ found at Verona, being in possession not only of an engraving of two species of this fossil which was executed for that gentleman by Antonius Gregori, and which are here copied, Plate I. Fig. 17 and 18, but of the manuscript account of the fossils drawn up by Mr. Strange himself.

Plate I. Fig. 18. "Stella marina fossilis minima, pentagona, stella pentaradiata in superficie posita, more echinanthi, et echino-spatagi, centro stellæ perfecte rotundato; radiis ferme ovalibus: superficie corporis sublævigata; colorem præbens, qui ex albo in flavescentem leviter vergit. Substantia gaudet calcarea. Invenitur frequens ad Castrum Divi Fælicis intra urbem Veronæ: naturalem autem invenimus in littore Neapolitano ad Cumas Baiarum."

Plate I. Fig. 17. "Stella marina fossilis, minima, pentagona, stella pentaradiata in superficie posita, centro stellæ perfecte rotundo; radiis autem ovato-acuminatis; superficie corporis lævigata, colorem exhibens alboflavum. Eadem substantia gaudet calcarea, et in eodem loco invenitur cum altera specie supra descripta."

"Species hasce stellæ marinæ fossilis pentagonæ sæpius vidi Romæ, Florentiæ, Bononiæ, Veronæ, Augustæ Taurinorum, et alioquin in quam plurimis Italorum musæis: nihilominus a nemine, quod sciam, hucusque descriptæ sunt. Inveniuntur tantummodo ad Castrum Divi Fælicis, intra urbem Veronæ, ut supradixi, in cæteris Italiæ provinciis conchyliferis nondum vidi."

It is with much pleasure I am also able to place before you another species of these minute stellites. The specimen from which the

copies, Plate I. Fig. 19 and 20, were made, having been originally in Mr. Strange's museum, was most probably obtained, with the former, from Verona.

Plate I. Fig. 20, exhibits the interior part of the fossil. The radii are connected at their sides by a substance, which, in the recent animal, was doubtlessly membranaceous. The mouth is surrounded by five sub-cordiform substances, disposed between the central terminations of the radii.

Plate I. Fig. 19, represents the superior surface, which appears to have been smooth. The radii, however, are here unexpectedly sulcated; a circumstance which, however, may have proceeded from the contraction of the membrane over them, in its dried state.

In its general appearance, this stellite resembles the *Stella cartilaginea* of Aldrovandus; or *Stella membranacea,* as Linck would rather call it. But its great degree of comparative thickness, and a curiously-figured process on its sides, mark an essential difference between the two, besides that of their size.

You have perceived, by the preceding account, that the fossil remains of these animals are rare. But you will also discover, that as far as my reading and observations extend, that the difference between the fossil remains and the recent animals does not appear to be so great as was observable, whilst examining the fossil animal remains noticed in the former volume.

LETTER II.

ECHINITES......ARRANGEMENT OF LESKE ADOPTED......THE VARIOUS SPECIES OF THESE FOSSILS DESCRIBED......*ANOCYSTI*, DIVIDED INTO *CIDARES* AND *CLYPEI*.

The next subjects of our inquiry are the fossil substances termed *Echinites*, the mineralised remains of the echinus; an animal of a roundish form, covered with a bony crust, approaching nearer to the coverings of the crustaceous than to those of the testaceous animals, and furnished with moveable spines; the mouth being placed beneath. The characters of many of these bodies are so remote from each other, as to seem to point out the propriety of considering the whole as forming a distinct order of vermes, thus marked out as different genera, possessing other characters, which would well serve for the distinction of species.

Many have endeavoured to bring the incongruous assemblage in the Linnæan genus, *echinus*, into a more lucid and instructive arrangement. To this work the labours of Muller, Phelsum, Bruguiere, and Lamarck, have much contributed: but to no one is more merit due, in this respect, than to the industrious Leske, the ingenious commentator on Klein's useful work. It is intended, in the following pages, chiefly to be aided by the arrangement of Leske, who has also availed himself of the labours of Phelsum and of Muller.

Agreeable to this arrangement, the first class of these bodies which we shall examine is that of the Anocysti, the vent of which is in the

vertex. These are considered as included in two divisions; *Cidaris* (the turban), and *Clypeus* (the buckler).

The first natural family in which these bodies may be placed, appears to be that of *Cidaris*. The characters are: hemispherical, globular, or suboval; with porous ambulacra, diverging equally on all sides, from the vent to the mouth; vent vertical, mouth beneath and central.

These, from their rounded forms and their different protuberances, are supposed to resemble turbans, beset with their several ornaments. From other characters, derived from their spines, they have obtained the name of sea-urchins, sea-hedgehogs, sea-thistles, &c. and those in a petrified state have obtained various names, agreeable to the particular notions which have been entertained respecting their origin. Thus they obtained the name of *ombria*, from the Greek word ὄμβρος, signifying the heavy rain, in which they were supposed to fall; *brontia*, from βροντη, the thunder, by which they were supposed to be thrown to the earth; *ceraunii lapides*, from κεραυνος, the lightning, by which they were supposed to be generated and formed in the air; *chelonites*, from their resemblance, in their sutures, to the shells of the tortoise; and *ova anguina*, from their having been even considered by some as the eggs of serpents.

Of the fossils belonging to this family, the first species is *Cidaris esculenta;* which is hemispherical, with small, nearly equal sized tubercles between the ambulacra. This species appears to have been rarely found fossil; it having been described, in this state, only by Aldrovandus, *Mus. Metal. p.* 456; and by the editors of the description of the museum of Moscardo, *Mus. Moscardi, Lib.* II. *p.* 177; and of Calceolarius, *Mus. Calceolarii, p.* 412. A near approach to this echinus is, I think, to be seen in the beautiful fossil from France, Plate I. Fig. 2, from the late Mr. Forster's collection. *C. saxatilis* chiefly differs from the preceding, in its ambulacra being narrower, and in its being smaller, and of a more depressed form. It is supposed,

by Leske, to have been frequently found fossil; he believing it to be figured as a fossil by Plot, *Nat. History of Oxfordshire*, Pl. V. Fig. 5; and copied by Lister, *de lapid. turbin.* Fig. 23. To this species he also refers the echinites figured by Bourguet, *Traité des Petrifications*, Fig. 336, as well as some of the echinites figured by Abilgaard and one or two others. *C. hemispherica*, which is however very properly suspected by Leske to be only a variety of *Echinus esculentus*, is, as was observed of that species, not a frequent fossil: it is, I believe, depicted as such by Walch only, *Monum. des Cat.* Pl. E. II. Fig. 1; and copied by Leske, Tab. xl. Fig. 7. *C. angulosa* appears also to be depicted by Walch only, *Monum. des Cat.* Pl. E. II. Fig. 5. The specimen is of the small variety. Leske describes and figures a small echinite, a variety of this species, *echinites excavatus*, from Verona. Another fossil from that place, which I possess, seems to be another variety of *C. miliaris saxatalis*, apparently *echinus gratilla*, Linn. Its characters are, ten ambulacra, with three rows of double pores, and five broad and five narrow areæ.

The above are considered by Klein as comprised under the genus *miliaris*, from their tubercles being of the size of millet-seeds. Those which we have next to examine, he considers as forming a genus, which he names *variolata*, from the size of the tubercles, and have been supposed to resemble the Turkish turban. *Cidaris diadema*, of this genus, does not appear to have been known to exist in a fossil state.

The echinite, Plate I. Fig. 4, from Wiltshire, approaches, however, very nearly to this species. It has ten areæ: in the five larger are two rows of tubercles; those just above the margin being large, and those above and below these gradually diminishing. These tubercles are all pierced in their apex, and have the margin of their base crenulated, as in those of the next genus, and surrounded by a granulated surface. The smaller areæ project beyond the larger, and are formed of two rows of miliary tubercles. The ten ambulacra are porous, each being formed by two rows of pores disposed in pairs.

The very uncommonly perfect specimen, from Stunsfield, Oxfordshire, Plate I. Fig. 8, in which a considerable number of spines are still adherent to the shell, appears to be of the same species with the last fossil.

As far as the characters can be traced, on the inside of the shell, it appears, that to this species the specimen, Plate I. Fig. 5, is referable. This extraordinary specimen, in which so many spines are seen imbedded in the flint, was considered as one of the most splendid fossils in the Leverian Museum.

Cidaris subangularis, of Leske, *Kleinii*, *Tab.* III. C. D. does not appear to be known as a fossil. *Cidaris fenestrata*, of Leske, *Kleinii*, *Tab.* IV. A. B. he thinks, is the analogue of the echinite figured by Scilla, *Tab.* XI. *No.* 1, *Fig.* 2; and by Walch, *Pl.* E. I. *a.* 1. The Echinus of Klein, *T.* IV. C. D. is considered by Leske as referable to *E. lucunter*, of Linnæus. He names it, therefore, *C. lucunter;* and observes, that it is rarely seen petrified: he, however, believes the fossil echinus, figured by Morton, *Nat. Hist. of Northumberland*, *P.* X. *F.* 2, to be of this species.

Echinites ovarius, *Langii*, is a small fossil, in which the characters of the species are discoverable. It is figured by Plot, *Hist. of Oxfordshire*, *Plate* V. *Fig.* 6, and copied by Lister, *de Lap. turbin.* *Fig.* 24. Lhwydd has also given a figure of this fossil, *Lithophylacii Ichnograph.* *Tab.* IX. *Fig.* 940.

Small specimens, of an elliptical form, are found in the Wiltshire chalk-pits, which appear to possess the characters of *C. fenestrata*, of Leske and of Klein, and which are figured by the latter, *Tab.* IV. A. B. But the echinus, of which three specimens are represented by Klein, Tab. V. *a*, *b*, *c*, named *C. rupestris* by Leske, has perhaps an equal claim to be the analogue of this Wiltshire echinite, the difference not being ascertainable; but the agreement is by no means sufficient to warrant their being assumed as of the same species.

C. calamaris araneiformis, *stellata*, *radiata*, *violacea*, do not appear

to have been remarked in a mineralised state. *C. circinnatus* is only known as a fossil, and is figured by Rumphius, *Amb. Pl.* LIX. *Fig.* C. and by Breynius, p. 55, who names it *Echinometra Circinnata.*

The chalk specimen, Plate I. Fig. 10, from Kent, does not sufficiently agree with any species with which I am acquainted, to allow of its being supposed to be exactly analogous. It may, however, be considered as belonging to this genus *(variolata.)*

The third genus of *Cidaris* is *C. mammillata.* The first species of this genus is distinguished by Leske by the name of the genus, and figured by Klein, Tab. VI. A. B. C. D. The shell of this species is elliptical and depressed. The areæ are, five large, and as many small, beset with papillæ, not perforated, and of a size proportioned to the areæ: the ambulacra are singly porous. This species is not very common in a fossil state. The fossil referred to by Leske, in Bourguet, Fig. 337, is certainly of this species; but that of Lister cannot be spoken of so decidedly.

The next species, *C. papillata, Lesk.* and *E. cidaris, Lin.* the moorish turban *(cidaris mauri)*, is round in its circumference, and rather depressed. It has five areæ, on which are alternately disposed two rows of mammillæ, each of these being surmounted by a perforated papilla, crenulated at its base, and surrounded by a distinct groove: the rest of the area being filled by minute puncta and granular projections. Each papillary tubercle of this echinus has its own plate. Between each pair of ambulacra, which are biporous and undulating, is a narrow granulated band: these are considered by Leske as the less areæ.

Petrified specimens of this species have been frequently figured and described. These are, the *ova anguini* of Pliny, and the *brontiæ* of Agricola. They are also figured by Plot, *Hist. of Oxfordshire*, Tab. V. Fig. 3, 4; and copied by Lister, *lap. turb.* Fig 22 and 25. Lhwydd, Tab. 12, Fig. 910, has depicted a fragment; and Morton, two complete specimens, *Hist. of Northumberland*, Tab. 10, Fig. 3, 5.

Representations also, of this species, are seen in most of the works of the foreign oryctologists.

In the figures given by Drs. Plot and Lister, considerable difference is observable. The form of the one is rather orbicular and depressed, and of the other somewhat conoidal: in the one are no papillæ, whilst in the other they are well preserved. Leske, who has remarked the difference very correctly, explains it, in part, by considering the latter as a silicious cast: a circumstance which fully accounts for the absence of the papillæ; but the difference of their form remains unaccounted for. An examination, however, of the fossils figured Plate I. Fig. 9 and 11, will, I think, show that this difference is only to be explained, by supposing the two fossils to be of two distinct species, or at least varieties.

In the echinite from Oxfordshire, of a globose form, Plate I. Fig. 9, the narrow strip of area, edged by the ambulacra, is formed by four rows of small and equal sized granular tubercles; whilst in the other, Plate I. Fig. 11, from Kent, these areolæ are wider; and, except towards their superior and inferior extremities, are composed of six rows of granular tubercles, which are large in the external rows, and diminish as they approach the centre. Its papillæ, though perforated in the apex, are not crenulated at the base. The much greater space of granulated area between the papillæ, and the conoidal form of the shell, also help to constitute a difference so great, as to lead to the opinion, that it should be considered as a distinct species. If this should be admitted, the species might be distinguished as *cidaris papillata conoidea.*

The echinite from Wiltshire, Plate I. Fig. 6, beautiful from its original formation, and estimable as a fossil, from its state of preservation being such, that even somewhat of the original colour of the shell is still to be perceived, partakes so much of the characters of *C. mammillata* and *papillata*, as to render it difficult to determine with which it should be arranged. Like the former, its less areæ

equal half the width of the larger, both being ornamented with papillæ of a proportionate size; but, like the latter, its papillæ are perforated in the apex, and crenulated at the base; and this is the case even with those papillæ which are disposed on the less areæ. The pores of the ambulacra, as in the former, diminish in number as they ascend; and, as in the latter, are closely bordered by granular tubercles. It should perhaps be considered as a variation of *C. papillata.*

Of *Cidarites coronalis* it is impossible to speak with decision, the specimens have been so rare and the descriptions so meagre. *C. corollaris*, Plate I. Fig. 7, specimens of which have been so generally spoken of among the early oryctologists, as *ombriæ* and *ceraunicæ*, is evidently, as is very justly remarked by Leske, merely a silicious nucleus. These nuclei vary in the figures and markings: they are all, however, rather orbicular; but some are much more depressed than others. But their differences are not such as can at all oppose the opinion, that they are casts of different species of *C. miliaris* or *variolata.* The large protuberance in the middle of each side, is evidently formed by the excess of silicious matter, beyond that which was necessary to fill the shell.

With equal accuracy does Leske suggest, that the assumed genus of Klein, of *C. asterizans*, does not merit the being considered as even a distinct species: and I am happy in being able, I conceive, to point out the genus, at least, to which this fossil may be referred; which seems to be that of *C. variolata.*

In the remarkably perfect specimen of a variation of *C. papillata*, Plate I. Fig. 6, a view is obtained of the verrucous appendage, which, in perfect specimens, is frequently found surrounding the superior opening of the *anocysti*: of the use of which appendage, notwithstanding the conjectures of Klein, it must be admitted that nothing is known. A reference to this peculiar organization, it is hoped, will assist in explaining the riddle which Walch and Leske, with M. Genzmer, have found so puzzling. In Knorr's splendid work, *Supp.*

x. *a.* Fig. 3, 4, is represented a fossil with its cast, which M. Walch considers, with M. Genzmer, as an echinus totally different from any with which we are acquainted. There are in this fossil no tubercles, ambulacra, nor sutures, as in other echini; but its surface is nearly covered with a kind of trelisse work, formed by lines passing in almost every direction, so as to form figures bearing somewhat of a stellated appearance. A slight sketch, showing the form of the surface of this fossil, as given by Walch, is shown Plate I. Fig. 14.

Plate I. Fig. 12, is an echinite found in the green silicious sand, so frequent in several parts of Wiltshire. The figure here given is magnified to about twice the size of the fossil. Round the superior opening of this echinite may be seen a remarkable extension of the appendage above mentioned; formed chiefly in roundish plates, connected together by numerous short filaments, and reaching over nearly a third part of the surface. In another specimen, these plates are hexagonal, and exactly fitted to each other. Plate I. Fig. 13, is another echinite from the same part, which is particularly interesting, from its appearing to be highly illustrative of the fossils above mentioned. The anal appendage is here seen, with a trelissed surface, almost exactly similar to that of M. Walch's fossil, and extending so low down, as to cover nearly one half of the echinite. If, indeed, this surface had extended over the whole echinite, it would have very closely resembled M. Walch's fossil, and have yielded us no further information: but sufficient of the inferior part of the surface of the echinite is left uncovered, to allow us to discover, that it has all the characters of a beautiful variation of the *C. diadema.*

Still, however, we are without any positive information as to the nature and office of this part, which is so singularly organised. It is on future specimens, and on further observations on the living animal, that we must depend for information on this subject. Whether this is a permanent appendage or not; whether it belongs to particular species only; or whether it is a part essential to the animal of each

species, serving to model the increasing shell, or to perform some other important service; are questions which must be answered by some future investigator.

The genus *C. assulata*, of Klein, is undoubtedly unfounded, since the distinction, which is derived from a distinct view of the assulæ, or plates, composing the shell, and of the sutures by which these are connected, depending merely on the thickness with which the tubercula are disposed, and on the bowldered state of the shell, cannot be regarded as even a specific distinction.

Of the several species placed by Klein under this assumed genus, none have been noticed as fossils, except *C. Sardiaca Klein*, Tab. IX. A. B. by Scilla, Tab. XVI. Fig. 1, and Tab. XXVI. Fig. B.; *C. Botryoides, Klein*, Tab. XI. H. by Aldrovandus, *Mus. Metal.* p. 457; and *C. Toreumatica, Klein.* Tab. X. D. E. by Leske, Tab. XLIV. Fig. 2.

I cannot introduce the necessary notice of the *Echinites favagineus* in any better place, I presume, than this. The *echinitæ* thus named bear on their surfaces hexagonal cavities, which give to the fossil somewhat of the appearance of a honeycomb. These fossils have been noticed by Encelius, Wormius, Olearius, Oliger, Jacobæus, and others; but without any rational conjecture having been offered as to their nature and origin, until the attention of M. Walch was attracted by a very beautiful specimen, and his ingenuity was exercised in its examination, *Monumens des Catastrophes*, Tome II. Sect. 1, p. 155. This fossil he describes as a crystallised cast of an echinite, composed of hexagonal cells, resembling those formed by the bee. These cells, he observes, agree exactly in their margins with the shape of the plates of the echinus, with which they also agree in their general form; and hence he infers, that the sutures, by which the plates were connected, had influenced the formation of these hexagonal cells.

In answer to the inquiry, in what mode is this influence exerted, M. Walch remarks, that the cavity of the shell being filled by any crystallising fluid, the first formation of crystals would be, that which

would fill up the small spaces existing at the articulation of the plates; and thus would be formed the bases, or margins, of these hexagonal conical cells. These being formed, he thinks, on the principle that homogeneous particles are most likely to unite, that the successive approximation of crystallising particles will take place on these hexagonal crystallized margins, rather than on the intervening spaces of the shell itself; and that, by the gradual approximation of the lines of crystals they formed, have resulted the conical cavities described.

A specimen which I possess, being the internal part of an echinite from the Kentish chalk-pits, will serve very much to illustrate and confirm the observations of M. Walch. The crystallizations of calcareous spar are here seen formed on the internal surface of the plates, the basis of the crystals being the margins of the plates. In the silicious nucleus of M. Walch, the crystals had formed an hexagonal cavity; but, in this calcareous mass, the crystals are solid: a difference which might proceed from the silicious crystals, in the former case having been formed on the calcareous crystals, which, being afterwards removed, would necessarily leave the inferior part of the silicious crystals hollow.

Small specimens of *cidares*, in a pyritous state, are sometimes found, with other fossils, in the Isle of Portland. Very minute shells of this kind are also found in the Devonshire whetstone, in the state of calcedony: they are also found in a silicious state in the green sand of Wiltshire.

The echini of the second section, or division, of *anocysti*, are distinguished as *Clypei*, from their similitude in form to the round bucklers of the foot-soldiers of the ancients. The first species of these is, *Clypeus sinuatus*, *Lesk.* the *Echinus sinuatus*, *Linn.* Plate II. Fig. 1. The upper surface is convex, and divided into ten areæ by ten striated ambulacra. One of the areæ is also divided by a groove, hollowed out from the centre of the shell to the margin. The ambulacra, at parting from the centre of the shell, expand, but

contract at the margin, and thus continue to where they meet in the centre of the lower part of the shell, which is rather excavated and grooved where the ambulacra pass. The whole of the surface of the shell is thickly beset with granular tubercula, the largest of which are surrounded by small circular risings. This species is figured by Plott, Tab. II. 9, 10, and is found chiefly at Tangley, Fulbrook, and Burford, in Oxfordshire: they are also found in Gloucestershire. Plott's engraving is copied by Lister; and Lhwydd, n. 971, as well as Morton, p. 233, both describe this fossil.

It is of this fossil that Dr. Plott informs us, *Hist. of Oxfordshire*, *p.* 91, that the centre of these rays being never placed on the top of the stone, but always inclining to one side, as that at the bottom does to the other, the axis lying obliquely to the horizon of the stone, gave occasion to a learned society of virtuosi, that during the late usurpation lived obscurely at Tangley, by consent, to term it the polar stone; since, by clapping two of them together, they made up a globe, with meridians descending to the horizon, and the pole elevated, very nearly corresponding to the real elevation of the pole of the place where the stones are found.

The *Cl. hemisphæricus*, Lesk. Tab. XLIII. Fig. I. taken from Lang. p. 119, does not appear to belong to this section; even *Cl. quinquelabiatus*, Lesk. Tab. XLI. Fig. 3, taken from Walch, Pl. E. III. Fig. 4, is in such a state as will hardly allow of determining its real species. *Cl. Conoideus*, Lesk. Tab. XLIII. Fig. 3, appears to be a rare petrifaction, and but little known. It seems, however, to agree in every respect with *Echinus magnus*, Aldrov. *Mus. Met. p.* 456.

LETTER III.

CATOCYSTI, DIVIDED INTO FIBULÆ, CASSIDES, SCUTA, AND PLACENTÆ......FIBULA, SUBDIVIDED INTO CONULI AND DISCOIDES...... CASSIS, SUBDIVIDED INTO GALEÆ, AND GALEOLÆ, INCLUDED IN ECHINOCORYS......SCUTUM, ECHINANTHUS......PLACENTA, ECHINODISCUS......ECHINOCYAMUS.

We now arrive at the second grand division, or family, of Echini, Catocysti, the opening for the vent of which is in some part of the base of the shell. The first section under which these are arranged by Klein is that of *Fibula*, a name which is generally adopted; although the echini it includes bear no resemblance to fibulæ, but rather to clothes'-buttons, to which the word is now made to apply. These echini are divided into two genera. The first, *conulus*, contains those which rise from a circular base into a cone, with an acute or obtuse vertex, from which five pair of punctated or crenulated lines, or ambulacra, pass, dividing the shell into five large and five small areæ, that in which the anus is placed being rather the largest. By some oryctologists these have been termed *Bufonitæ* and *Scolopendritæ*, and by others, *Pilei;* and by the English *Capstones.*

The species which constitute this genus are only known as fossils, and are so variously distinguished by the modification of their forms, and by other little circumstances, as to render their varieties too numerous to admit of being specified.

Conulus albogalerus, Lesk. *E. albogalerus*, Linn. deriving its name from the white conical caps of the priests of Jove, is the first species

of this genus. This species is in the shape of a pointed five-sided cone, in the vertex of which are five small foramina, from which proceed five small areæ, bordered on each side by biporous ambulacra; the remaining space being filled by five larger areæ. The mouth is small, somewhat retracted; and the anus sometimes inclining to oval. This species is figured and described by most oryctologists, in consequence of the frequency with which it is found. But it exists nowhere, perhaps, in greater number, than in England; particularly, according to Dr. Plott, in the southern counties, where the black flint most abounds. Plate II. Fig. 10, is a fossil of this species, from the Kentish chalk-pits; and Fig. 11 is a representation of its under part.

Leske refers the *Echiniten pileatum, ore pentagono* of Melle, Tab. I. Fig. 2, to this genus, considering it as its second species, which he distinguishes as *Echinites depressus*. The *Globulus* of Klein, Tab. XIII. Fig. c—k, and Tab. XIV. Fig. a—k, is denominated *Echinites vulgaris* by Leske, and considered as the third species. These fossils are in general not more than half the size of *Conulus albogalerus;* and, like it, are divided into five large and five small areæ, by ten ambulacra. In general, these fossils are merely casts, and do not retain sufficient distinctive characters to allow of their subdivision, even into varieties. These fossils, like the former, are described by almost every oryctologist, and are very frequently found in the gravel of different parts of England: they are the *chelonites* of Mercatus, and the *brontiæ* and *ombriæ* of many authors. Plate II. Fig. 3, is a fossil of this species from Sussex. Two other species of this genus are mentioned by authors, varying in the number of their ambulacra; these are, however, of very rare occurrence. One of these species has only four fascia or areolæ, and is named *Echinites quaterfasciatus*. This is figured by Leske, Tab. XLVII. Fig. 3, 4, 5. It is also figured by Walch and Gehler. The other species, *Echinites sexiesfasciatus*, has six bands. This species has been figured by

Klein, *Act Gedan.* II. Tab. V. Fig. 14 and 15, as well as by the authors just mentioned.

The second genus of this section is *Discoides,* the only species of which is *subuculus,* and is only known as a fossil. The surface of this is divided in the same way as the former species. The periphery is circular. The vertex is much more depressed, and the base rather more concave. One of this species is represented Plate II. Fig. 7.

Another genus is here introduced by Phelsum, and named by him *Echinoneus.* It agrees, in every respect, with *E. Discoides* of Linnæus, except in its periphery, which is rather ovate, and not angular. It has the same number of areæ and ambulacra; the latter being biporous, and having the pores more distant from each other than in the preceding genus.

The second section of the class of CATOCYSTI is *Cassis (helmet-stone.)* These echinites are distinguished by an oval base, from which the shell rises in a vaulted helmet-like form. One extremity of the oval, that in which the vent is placed, is commonly more produced and acute than the other. Klein divided these echinites according to their size, into two genera, *galeæ* and *galeolæ;* but Leske, considering the difference of size as not sufficient to affect the genus, has very properly included them both under the genus *echinocorys.* As the echini of this extensive genus are only found fossil, the changes which they have sustained from various kinds of injuries, prevent, in many instances, their species being exactly determined.

The first species, *Echinocorys scutatus,* Tab. XV. A. B. *Kleinii,* is in general as high as it is long. It has, like most others, five large and five small areæ, separated by biporous ambulacra. Minute tubercula and granulæ exist on some parts of the surface, and particularly on the base and near to the mouth. The base, the circumference of which is nearly elliptical, is almost flat: the edge, however, is slightly rounded; and, in its middle, a prominent slip extends from the mouth to the anus, near to which, on each side, two bands of minute

granulæ are disposed. The mouth is reniform, placed crossways, at the broadest extremity. The anus is of a roundish oval figure, and is near to the narrow extremity. The spine, which gives name to the species, runs down from the vertex and along the narrower end, and becomes attached to the higher edge of the anus. Plate II. Fig. 4, is a species from the Kentish chalk-pits.

E. ovatus, Lesk. *Galea wagrica, vertice nuda*, Klein, differs from the former species in being more depressed in its circumference, being of a rounder oval; and in being without the crest-like ridge which runs along the back of the other species. Another species, *Echinocorytes quaterradiatus*, has been formed from an echinite figured and described by Melle, Tab. I. Fig. 7; but I suspect the absence of the fifth ray has proceeded from the omission of the engraver, since, in the remarks on this fossil which are made by Melle, at some length, this remarkable character is not noticed.

Among the smaller *echinocorytes*, most of which are mere nuclei, certain particulars are observable, which, though hardly sufficient to distinguish them as varieties, still deserve notice. A variety is marked by Leske, Tab. XVI. C. D. Klein, *Galeola papillosa;* in which, as he observes, the papillæ evidently result from the silicious matter which filled the foramina of the shell still continuing, whilst the shell which surrounded them is removed. Another, Tab. XVII. *a. b.* Klein, is named *G. undosa*, from the waving lines on its surface, formed by the silicious matter having insinuated itself between the edges of the plates forming the shell.

Part of a remarkable cast of a galeated echinite is shown Plate II. Fig. 9, said to be from France. Although this fossil is hollow, and retains such strong markings of the shell, it can still be only considered as a cast. Its substance appears to be pyrites of iron, which has suffered some decomposition, and has been since frosted over with minute quartz crystals. Its matrix appears to have been chalk, some of this substance being yet adherent to it on several parts. Its

formation appears to have taken place, by the shell becoming imperfectly invested, both on the in and the outer side, with the pyrites, which then obtained a partial covering of drusy quartz; the acid resulting from the decomposition of the pyrites subsequently removing the shell, the impressions, which are plainly discernible, showing the forms of the plates of the shell, and the sutures by which they were joined. That the quartzy incrustation took place previous to the removal of the shell, is shown by the spaces which the shell has left being left entirely free from crystals.

The third section of the class of Catocysti is named *Scutum* by Klein, and *Echinanthus* by Leske and Phelsum. The shells comprised under this section are of an irregular figure, resembling an oblong or angular buckler. On the base, which is concave, five grooves pass from the margin, and terminate at the mouth in the centre. The upper part is ornamented with five rays, which have been supposed by some to resemble a pentaphylous flower, and by others a five-rayed star. The mouth, which is pentagonal, is furnished with five teeth of an alated form and a plumose appearance, and is placed in the centre of the base, the anus being at the margin. The whole of the surface is beset with minute circular depressions, with central tubercles.

One genus, *Echinanthus, Lesk.* comprises all the shells of this section. The first species, *Scutum humile, Klein.* Tab. xvii. *a.* xviii. *b. Echinanthus humilis, Lesk.* is rather of an oval form, and is divided into ten areæ by five biporous, pentaphyloideal ambulacra, the five smaller areæ being comprised in the pentaphyloid surface formed by the ambulacra, and having grooves pass across them, and connecting the immediately opposite pores. Specimens of this species, in a mineralized state, are represented by Aldrovandus, *Met. Mus.* p. 499, Fig. 1: Scilla, Tab. x. Fig. 2, 3; Tab. xi. No. 2: *Walch,* Tab. E. V. Fig. 1, 2. This species is chiefly found in a petrified state in Malta and in Occitania. Dr. Shaw figures a fossil of this species found in the desert Marah, *Voyage to Barbary, &c. Fig.* 40, *p.* 128, *app.*

As this fossil may thus be seen figured, in its complete state, in the works of these authors; and as its cast is a more uncommon fossil, and will also serve to convey a satisfactory idea of the general form of this species, a small specimen of a perfect cast is represented Plate II. Fig. 8, from Malta.

Scutum altum, vel Echinanthus altus, has only yet been met with in a petrified state. It differs from the former species in being higher, and having wider ambulacra. Figures of it have been given by Scilla, Tab. IX. Fig. 1, 2; Bonan. *Nat. Hist.* Tab. XXXVI. Fig. 1; by Mercatus, *Met. Mus.* p. 233; and by Leske, Tab. LIII. 4. A specimen of this fossil, which I possess, may, I think, be considered as a variety from those which have been figured by the above authors. Although equally high, its sides rise not so suddenly, but more obliquely, to the vertex; forming, therefore, a more acute angle with the base. I obtained, at the sale of the Leverian Museum, a complete specimen, being the nucleus of the echinite of the above authors: it serves to give a correct notion of the structure, as well as of the form of this echinite. Pl. IV. Fig. 7.

Scutum ovatum, vel Echinanthus ovatus. The fossils comprised under this species of Leske, differ so considerably in form from the preceding, as seems fully to authorize their separation into two genera. The difference which is discoverable between different specimens of the oval scuta appears also to be such, as would fully warrant the separating of them, with Klein, into species, instead of into varieties, as has been done by Leske. Fossils of this form are figured by Aldrovandus, *Mus. Met.* p. 498, Fig. 1, 2; Mercatus, *Mus. Metal.* p. 232; Rumphius, *D'Amboinsche Rar. R.* LIX. Fig. D; and others. The one which is here represented, from Verona, Plate II. Fig. 5, is interesting on account of the distortion of its figure, and particularly of one of its rays.

Leske regards as a doubtful species, *Echinanthites orbicularis,* since the specimen from which he forms his species, and which is

taken from one of Knorr's plates, *Monumens des Catastrophes,* Tome II. Tab. E. III. Fig. 3, is too imperfect to give a correct knowledge of its characters.

The fossil, Plate II. Fig. 2, is, I believe, of this species, and has hardly suffered the least injury. It formed a part of Mr. Forster's collection; and is, I conjecture, from Oxfordshire. It needs no other notice of its form, than that it is nearly circular, deviating only in having that part of the shell, which is the region of the anus, a little more produced. It not having been thought necessary to figure the inferior surface, it is proper to observe, that it is slightly concave, the mouth being pentagonal, and the vent oval and transverse, and situated near the margin; but more on the under side, than it appears in the figure.

The echini of the fourth section, CATOCYSTI, are named *Placentæ,* by Klein, the shells being flat, like a cake, and variously formed. They are all ornamented with a pentaphylloidal flower. The mouth is in the middle of the base, and the anus near to the margin, or to the third region of the axis. This section is divided by Klein into three genera, *mellita*, *laganum*, and *rotula*, which are comprised by Leske in the genus *Echinodiscus,* so named by Breynius. The characters of this genus are, a depressed, discoidal figure, nearly flat on both sides; ambulacra imitating the forms of petals; a smooth central mouth with teeth; the top perforated with four large pores.

The *Mellita, honey-cake* of Klein, forms the first family of this genus. The species differ in the number of foramina, the situation and the form of the periphery.

Echinodiscus bisperforatus, E. quinquiesperforatus, E. sexies-perforatus, E. emarginatus, E. auritus, E. inauritus, E. quater-perforatus, do not appear to have been hitherto known in a petrified state. The fossil which is represented Plate II. Fig. 6, is the only fossil which I have seen of this family, and is undoubtedly one of the first species, *Echinodiscus bisperforatus,* as will appear, on a com-

parison with Klein's figure of the recent shell, Tab. xxi. A. B. and with Leske's description of that part, which is here in best preservation. "Ambulacra petalorum ovatorum figuram sistunt, atque singula ex serie simplici punctorum interiore, et striarum obliquarum, testam penetrantium, non tamen puncta interiora prorsus attingentiam, componuntur: in apice ambulacrorum puncta non conjunguntur, sed spatium intermedium relinquunt. Additamenta ad Kleinii dispositionem Echinodermatum." P. 196. This fossil, which was in the collection of Lord Bute, is, I suspect, from Verona.

The second family of this section is the *Lagana* of Klein. The species *Echinodiscus Laganum*, or *pancake* of Leske, includes, on account of their similarity, the first and third species of Klein, and are exemplified in Klein's Plate xxii. a. b. c. The specimen which is here figured, Plate III. Fig. 10, may be considered perhaps as only a variety of this species. The shell is white, and of a form between the oval and pentagonal. The mouth is central, and an obtuse pentagon; the anus is small and round, and nearly midway between the mouth and the margin. Five slightly hollowed lines, proceeding from the mouth, divide the under part of the shell into five nearly equal areas, by coinciding with the centre of the terminations of the ambulacra. These are ten, biporous and undulating; and form, on the upper surface, five pentaphylloidal figures, expanding at their extremities. This species is not noticed by Linnæus.

Echinodiscus subrotundus, Tab. xlvii. Fig. 7, Lesk.; Scilla, Tab. viii. Fig. 1—3. Leske, who had never seen this fossil, has copied his figure from that of Andræa, in *Litt. Helvet.* Tab. v. Fig. g. But the figures of Scilla and of Andræa do not, as Leske supposes, agree. In that of Andræa the edge is acute, and somewhat undulating; whereas, in that of Scilla, the margin is obtuse, and nearly circular. The fossil figured Plate III. Fig. 2, from Italy, agrees with the former in its edge being undulating.

This fossil is very nearly circular. Its upper surface is convex. The base is flat, with five narrow and slightly excavated grooves, extending in right lines, and at nearly equal distances, to the margin. The mouth is rather injured, so that its shape cannot be determined. The anus is small and round, and is placed at about a fifth of the diameter, from the margin, in an area which is rather smaller than the others. The ambulacra appear to have borne the figures of oval petals; and are each composed of a line formed of single pores, surrounded by three, four, five, or even six lines of minuter pores, obliquely disposed in very small grooves. What figure resulted from their approximation in the centre cannot be determined, as the shell is in that part broken.

On examining the surface of this fossil with a lens, it was found still to retain, in several parts, the small flat imbricating spines. These are represented in the sketch on the right side of the fossil.

Echinodiscus reticulatus is not known fossil. *E. Orbicularis*, Tab. XLV. Fig. 6, 7; *Lang*. Tab. XXXV. Fig. ultim.; is a depressed orbicular echinite, about an inch in diameter, with acute oval ambulacra, and ten porous rays in the base; the mouth round and the anus small, and midway between the centre and the margin. *E. Rosaceus*, Tab. XL. 4, *Lesk*. et Tab. E. III. 8, *Knorr*. differs from the former in being much smaller, and in its ambulacra forming a floweret, with very short petals, round the vertex.

Echinodiscus decies digitatus, ——— *octodigitatus et dentatus*, do not appear to be known as fossils.

Under the class *Catocystus* a new genus has been formed, by Phelsum, and named *Echinocyamus*. The generic characters are, ten stellated ambulacra, passing from the top in straight biporous rows; the mouth and anus adjoining in the middle part of the base. The shells of this genus are not known in a petrified state.

LETTER IV.

PLEUROCYSTI, ECHINARACHNIUS......COR MARINUM, SPATANGUS, AND ITS SPECIES.

The third grand class of Echini is the ***Pleurocysti,*** in which the vent of the animal is on some part of the side, or on the upper surface. The only genus of the first section, and which also contains but one species, is ***Arachnoides, Klein. Echinarachnius, Lesk.*** so named from its yielding, by its markings, the appearance of a spider's web. It is not known fossil. Of the second section, *Cor marinum,* or sea-heart, characterized by the bilabiated mouth being in the third region of the axis of the base, and the anus in the side of the truncated extremity, the first genus is *spatangus.* In this genus, or, as he terms it, family, Leske, with Muller, includes *spatangus, spatagoides, brissus,* and *brissoides,* not considering the absence of the groove to be a generic distinction, and finding that the animals agree in their general construction, as well as in their having a bilabiated mouth, and being without teeth. The first family is formed of *cordated spatangi, with a sulcated vertex.* The first species is, *Spatangus, cor anguinum,* Tab. XXIII. C. D. et Tab. XXIII. C. *Klein, cor anguinum Anglicum.* Plate III. Fig. 11, is a variety of this species. The characters of this shell are, its being cordated, and more or less oblong; the base, in some, flat, and in others rather convex; being beset, in this part, with miliary, and, in the superior, with fewer and smaller granulæ. The back is convex, and divided into five areæ, by as many grooved ambulacra, formed by four rows of pores, connected by transverse lines,

each two rows, uniting at the end of the grooves. Two of the ambulacra, the shortest, are directed obliquely towards the narrow truncated extremity; two others, longer, pass obliquely towards the broader end; and the fifth passes straight to the mouth, forming the dorsal groove. Along the middle of the opposite part, a keeled edge passes directly to the anus. The vertex is perforated by four large pores. The mouth is reniform; the upper lip triangular, and extended over the lower. The anus is round, and placed in the upper margin of the acute extremity. From the anus, a slight depression passes to the lower margin; at each of the angles of which is a protuberance, surrounded by a broad smooth surface.

Specimens of this species are found in many parts of Europe, but particularly in Germany and in England. They are the most frequent fossils in the chalk-pits of Kent and Essex, and are frequently found filled with flint. These are the *Echinites cordati vulgares* of Lhwydd, *Lithoph.* Fig. 964—967.

Two more varieties are noticed by Leske: the one, *sulcis crispis*, does not, in the figures referred to, appear to possess this particular character; and the other, *norvagicum*, Tab. XXIII. E. F. *Klein.* varies from the preceding, in being a little more oblong in its form.

Spatangus lacunosus, Tab. XXIII. A. B. Tab. XXIV. *a. b.* and Tab. XXVII. A. *Klein.* This fossil, which has indubitable claims as a distinct species, is of an oval form; its upper surface gibbous, and its under rather convex. At the vertex are two, or, according to Muller, four puncta. From the vertex immediately proceed four deeply sulcated obtuse ambulacra, with angular margins: within the grooves are four rows of pores, connected by transverse lines. The two posterior ambulacra, directed towards the narrower part of the shell, are shortest, being sometimes merely two deepish fossulæ: between the two anterior ambulacra is disposed another deep groove, which is also beset with striæ and puncta. On each side of the shell, are several gradually rising prominences; from which pass, in different

directions, several intercurrent lines, on which minute granular tubercles are very thinly disposed; whilst the general surface is covered with tubercles of rather a larger size. The mouth is small, and nearly round, according to Leske: its situation is, however, not pointed out, nor am I able to point out its situation in either of the three specimens which I possess. The anus is round, and placed in the upper margin of the narrower, and apparently truncated termination of the shell.

From some peculiarity of structure of this shell, the specimens are almost always distorted. Such is the case with all the specimens which I have seen, and with most of the representations of them. The recent shell is figured with its spines, in the sixth volume of *Encyclopedie François*, Pl. LIX. Fig. 4. The fossil is mentioned and figured by many authors, but none of the figures appear to exceed those of Scilla. The specimen figured in the present work, Plate III. Fig. 12, is from Malta.

Spatangus pusillus, Tab. XXIV. *c. d. e. Klein*, et Tab. XXXVIII. Fig. 5, chiefly distinguished by a deep dorsal groove, has not, I conjecture, been yet discovered fossil.

Spatangus radiatus. This species is only found in a fossil state. The shell is of an ovate circumference, and of a vaulted galeated form. The vertex is pierced with four foramina, where four transversely striated and biporous ambulacra arise. Two of these pass nearly half way down the shell, obliquely directed on each side of the posterior part: a dorsal lacuna also, in which are two double rows of pores, originates from the vertex, and, passing down the anterior part of the shell, is extended to the mouth. The shell is formed chiefly of pentagonal assulæ. The mouth, which is situated in an oblong pit, in the broader and anterior part of the base, is reniform, and beset with pores and tubercula, disposed in somewhat of a stellular form. The anus, which is nearly round, is placed in a pit at the posterior part, close above the margin. The shell is remarkably

firm and thick; and its colour, as well as that of the calcareous matter with which it is filled, is a light yellow. It is figured by Walch, Tab. E. IV. No. 1 and 2; by Klein, Tab. XXV.; and by Faujas St. Fond, *Histoire Naturelle de la Montagne de St. Pierre*, Pl. XXIX.

A faithful representation of this fossil is given Plate III. Fig. 4 and 5. This fossil has been sometimes termed *Spatangus Mosæ*, from the circumstance of the Meuse laving the hills at the foot of St. Peter's mountain, where it is found.

Spatangus purpureus, Tab. XLIII. 3, 4, 5, Tab. XLV. 5, *Lesk*. The recent shell, as figured by Leske, Tab. XLIII. 3, 4, 5, Tab. XLV. 5, but particularly in the latter plate, which represents the back of the shell, appears to agree exactly with the fossil which I have represented Plate III. Fig. 9, which I purchased from Mr. Forster's collection, and which I believe to be a Maltese fossil.

This fossil is of a subangular cordated ovate shape. Four large pores, near to each other, form, as it were, the centre in the vertex, which is rather flat; and at which four ambulacra, and a deep and wide dorsal groove, concentre. Each of the four ambulacra is of a lanceolate petalloidal figure, formed by two bending bands of a double row of oblong pores, each pair of which is connected by an oblique furrow. The small spaces, or areæ, contained within the ambulacra, appear to have been beset with very minute pores and tubercula; and a serrated line, passing through their centre, connects two rows of hexagonal assulæ. The remaining part of the superior surface is divided into five large areæ. In the anterior part is the dorsal groove, wide, rounded, and deep, passing from the base to the vertex, forming a semicircular notch in the margin, and narrowing as it rises. On each side of the dorsal groove is a raised triangular flat surface, bordered by two tuberous ridges, which, rising from the vertex, proceed downwards; the tubera enlarging, to the margin, and slight transverse risings connecting the opposite tubercles. Similar raised surfaces descend through each of the other areæ; and similar trans-

verse risings are observable over the whole upper surface. The flat raised surface, on the posterior part, is raised much above the rest. On this surface, ten sets of tubercles, lessening as they approach the margin of the area, are obliquely disposed, in two rows. On the two lateral raised surfaces, a like number of sets of tubercles are disposed, so as nearly to form angles along the central line. The rest of the surface appears to have been beset with numerous small tubercles; the larger of which, being connected at rather acute angles, with the tubercles of the raised surfaces, form undulating lines, giving, in many places, the figure of the letter W. From the ridges above mentioned proceed the angles observable in the circumference of the fossil; and from the transverse risings, the surface of the shell is formed, as it were, into numerous facets. This description of the recent echinus will be found to apply very nearly to the fossil here represented: the difference being only that which proceeds from the injurious changes which the fossil has sustained.

The inferior surface of the fossil is nearly destroyed; but from Leske's account, we learn, that it very nearly resembles that of *Spat. pusillus*, and *Spat. striato-radiatus*. The mouth is oval and transverse; the upper lip not covering, nor much projecting over, the under lip. In the superior margin of the narrow end is the transverse oval anus; and, in the inferior margin, is a reniform area.

Similar specimens are, I believe, rare. It has, however, been figured by Aldrovandus, *Mus. Met.* p. 475; Scilla, Tab. XI. Fig. 1; and by Allion, the editor of the French edition of Klein, and of the French Encyclopedia.

Spatangus depressus, Tab. LI. Fig. 1, 2, *Lesk.* Under this species are included those echinites which are of a flattened upper surface, of a subrotund and cordated figure, proceeding from a dorsal groove, and having five pair of ambulacral biporous rows: one pair, in some varieties, passing along the dorsal groove. The mouth is transversely placed in the centre of the base, and the anus in the middle part of

the narrower and higher extremity. This species is only known as a fossil; in which state the granular surface is generally removed.

Spatangites subglobosus, Tab. LIV. Fig. 2, 3. This shell is cordated, and, on each side, convex and subglobose; with ten striated and biporous ambulacra. Leske adds to these the following characters:—Four pores, in the angles of a trapezium on the vertex; also, in the apex, where the two pores unite, a little pit is impressed. The two neighbouring ambulacra form triangles, the bases of which are in the periphery, and their apices in the vertex. Two rows of pores in the dorsal lacuna reach to the mouth; and, from the vertex to the anus, a prominent ridge proceeds. Each area is divided by a serrated longitudinal suture, and is divided into assulæ by transverse lines, slightly arched: the assulæ of the larger areæ are heptagonal, and those of the less areæ are alternately heptagonal and pentagonal. The circumference of the middle of the base is granulated; but the superior surface is generally so worn, as to show only the traces of the granulæ: two fasciæ, free from granulæ, extend from the angles of the mouth towards the anus. The mouth, which is subreniform, is near to the grooved margin, and is surrounded by tubercles, disposed in a stellular form. The anus is near to the superior margin of the narrower and undivided extremity.

This description is given more fully, since the figures given by Leske do not accord with that of Lister, to which he refers. The figure given by Walch, Tab. E. IV. Fig. 3, 4, agrees exactly with that of Leske.

Spatangites ananchytis, Tab. LIII. Fig. 1, 2, *Lesk.* differs from the preceding, chiefly in its upper part being more conical, its base more flat, and its periphery more oblong. The figure given by Leske, is from a silicious nucleus; and the only specimen of this fossil, which I possess, is a spathose nucleus.

Ananchytis, seu Synochitis, of Mercatus, p. 316, and App. 89, appears to approach much nearer to the form of *Spatangites globosus*, than to that of this fossil.

Spatangites bicordatus, Tab. XLVII. Fig. 6, *Lesk.* In this fossil, which is but rarely met with, there exist, connected by a linear carinated ridge, two vertices, in which the ambulacra terminate. Both ends, thus becoming sulcated, the echinite is said to be bicordated.

Spatangites carinatus, Tab. LI. Fig. 2, 3, *Lesk.* This Spatangite, like the former, has a linear carinated ridge, connecting two vertices; but, unlike the former, the narrow anal termination is not sulcated. It is also figured by Baier, *Oryct. Noric.* Tab. III. Fig. 43.

The third family of this genus is considered by Leske as composed of those echini which form the genus *Brissus**, of Klein: the chief characters of which are—the back not grooved, but striated; four deep crenated and perforated sulci, as ambulacra; the base tumid; the anus and mouth patulous, and the latter bilabiated. None of the varieties of *Spatangus brissus*, into which, according to Leske, they all resolve, appear to be known in a mineralized state.

The genus *brissoides*, of Klein, is adopted by Leske as the fourth family of *Spatangi*. The shells of this family, like the *brissi*, are ovate, and the back striated, but not lacunated; the rays are flat.

Spatangus brissoides, Tab. XXVII. B. *Klein.* is ovate, oblong, subcordated; with four petaloidal, lanceolated ambulacra, with two rows of pores, connected by transverse striæ; large tubercles existing between the ambulacra; the rest of the surface being covered by granulated risings. The mouth subrotund and reniform, surrounded by pores disposed in the form of a pentagonal star; the middle of the base raised and tuberculated.

Spatangus ovatus, Tab. XLIX. Fig. 12, 13, *Lesk.* differs from the former, chiefly in being more convex; but this species does not appear to be known fossil.

* *Brissus.* This word, βϱισσȣς, is applied by Aristotle, and after him by Athenæus, to certain genera of echini. The name *Brittus* is also elsewhere applied to them. Αβϱυτος is the designation, then, of a genus of echini, corrupted from ἄβϱωτοι, i. e. *non commesu apti.*

Spatangites ovalis, Tab. XLI. Fig. 5, *Lesk.* copied from Walch, Tab. E. III. Fig. 6, is particularly interesting, in consequence of two of the ambulacra, proceeding from two points, at nearly half an inch distance from each other. The bands formed by three pair arise at the vertex of the shell, the middle one passing straight, and the lateral ones obliquely, to the region of the mouth; whilst the two posterior pair proceed from a point of the shell just above the anus, and pass round the margin on each side of the anus. The specimen figured Plate III. Fig. 3, differs from that of Leske and Walch in being larger, and not having its parts so distinctly visible, as to be able to determine the form of the assulæ; which, in the otherwise very correct description of this fossil by M. d'Annone, are said to be quadrilateral, whilst in the figure they are depicted pentagonal. Three species appear to exist in a fossil state, in which the ambulacra do not arise from the same point in the vertex of the shell.

The specimen figured Plate III. Fig. 8, is evidently of the family *brissoides*, and might be named *Spatangites brissoides ovalis.* The form is oval; the base concave, and rounded at its margin: in the centre, where the mouth, which is oval, is placed, the ten biporous ambulacra terminate separately: the back is convex; near the centre of which are four foramina, and the superior lanceolated terminations of each pair of ambulacra: the anus, large and pyriform, is placed on the back, just above the margin.

The following species deserve, perhaps, as is observed by Leske, to be considered as forming a distinct genus, which might be placed between *echinanthus* and *spatangus.*

Echinites pyriformis, Tab. LI. Fig. 5, 6, and Tab. XLIV. Fig. 7, *Lesk.* The shell is ovate, gibbous, and rather acute at one end; the base flat. On the back originate five porous, sub-petalous, ambulacral bands, which reach to the periphery: a carinated line divides the back of the shell, as it were, in two parts. In the middle of the base is the round sub-pentagonal mouth, furnished with five prominent lips.

Between each of the two prominent lips a double series of pores unite, forming a five-rayed star round the mouth. The anus is round, and placed in the upper part of the acute extremity of the shell.

One of these fossils, from St. Peter's mountain, is delineated Plate III. Fig. 6.

Echinites lapis caneri. Tab. XLIX. Fig. 10, 11, *Lesk.* This name was given by Leske, from a supposed resemblance to the stones commonly called crabs'-eyes. The shell is obtusely oval; in the vertex, which is excentrical, are four pores; and there meet five biporous, ovato-lanceolated, petaloidal ambulacra, divided at their points. The base is slightly excavated; the mouth is in the centre, but nearer to the narrow end; the anus is oval, and raised on the broader end, in the upper part of a rounded groove. Plate III. Fig. 7, represents a specimen, which, I have reason to believe, is from Switzerland.

Echinites patellaris, Tab. LIII. Fig. 5, 6, 7, *Lesk.* This species, which is smaller than the preceding, is described as differing from all others, except as to the mouth and anus, which agree in their situation with those of the two last species. The difference appears chiefly to consist in the shell being considerably depressed, and the ambulacra being disposed in the form of a star. The shell is ovate in its periphery, the back is slightly convex, and the base gently hollowed.

I do not know if the curious echinite, Plate IV. Fig. 10, from Verona, has been yet described. It is very flat, of a rude, sub-cordate form, and possesses a finely-granulated surface, which seems to be so formed by the points to which the minute spines have adhered. I must however acknowledge that I have only been able to discover one aperture in this fossil, which is in its margin.

LETTER V.

SPINES OF ECHINI......ARRANGEMENT OF FOSSIL SPINES.

It so rarely happens, except in some particular situations, and under some uncommon circumstances, that the spines of the echinus continue long adherent, even to their recent shell, that it is not at all surprising, that instances of their being connected in fossil specimens are exceedingly rare. Soon after the death of the animal, unless it happens to have been placed under such circumstances as prevent the decomposition and resolution of those membraneous and muscular parts on which the connection depends, the spines become disengaged, and fall off from the shell. This circumstance being considered, with that of the numerous chances of injury, after the death of the animal, and previous to the period of its becoming a subject of the mineral kingdom, it indeed appears wonderful that any fossil specimens should exist, where the shell and the spines continue united.

From the opportunities of seeing the shell and spines in connection, in a mineralized state, being so exceedingly infrequent, proceeds, in a great measure, the difficulty of succeeding in the attempt to ascertain the particular species to which the various fossil spines belong. To the labours of Klein, Phelsum, and Leske, I must be chiefly indebted for such information as I may be able to convey to you on this subject. I shall however endeavour, as I proceed, to confirm their observations, or correct their opinions, by occasional references to such specimens, in my own possession, as seem to determine the relationship between the particular species of spines and of echinal shells.

The Aciculæ *capitatæ,* in their respective varieties of forms and colours, are found chiefly belonging to the echini of the genus *miliaris* and *variolata.*

Instances of their preservation, in a petrified state, have not been frequently mentioned. Two unconnected specimens are figured by Volkmann, *Siles. Subt.* Tab. xxx. Fig. 17, 18; and it is this species of which Gesner speaks, *de Petrificat.* p. 36 *d.* as aculei, s. radioli leves, exquisite cuspidati. Two specimens are also figured by Müller, *Delic. Natur.* Tab. D. I. Fig. 1, 5. But no instances are given, in any author, of their preservation in a fossil state, in connection with their shell. In the specimen in chalk, Plate I. Fig. 10, one of these spines, of a subulated form and striated surface, is seen in that situation, which gives full reason to suppose its relationship to the shell which it accompanies. The flint specimen, Plate III. Fig. 1, is interesting, from its showing that *E. saxatilis* is provided with spines of a similar shape: in one part the spines are seen, with their articulating terminations, lying close to the points to which they belonged; and in another, one of the spines is seen in the substance of the flint, still attached to the shell. In the remarkably fine specimen from Stunsfield, in Oxfordshire, Tab. I. Fig. 8, some little variation is observable with respect to the spines. Like the former, they are striated, subulated, and rather bent; but they gradually, though very slightly, swell a little about their middle, and thence become somewhat fusiform.

In the flint fossil, Plate I. Fig. 5, which was considered as one of the most valuable in the Leverian Museum, spines of this class are still seen adherent to the echinital crust, and imbedded and passing into the solid flint. These are subulated like the preceding, but are more straight. The echinite of this specimen appears to be of the variolated kind.

In the interesting specimen of *Cidaris papillata,* from Calne, Pl. IV. Fig. 20, spines of the same class are fixed. But these appear to have been longer, and more of a cylindrical form than those above described.

In a fossil from Hertfordshire, in which an echinite, probably of the variolated kind, is involved in a mass of pyritous clay, innumerable subulated and capitated aciculæ are seen piercing through and laying in the surface of the mass.

The capillary aciculæ are so small as to give but little chance of detecting them, mineralized, in an attached state; and I know but of one instance in which they have been found petrified and adherent. This has lately occurred in a mass of silicious cordated echinites from Devonshire, imbedded in a matrix of chert. In this specimen, the capillary acicular spines are accumulated on the echinites in prodigious numbers.

The spines comprised in the class of SUDES are very numerous; but, for the reasons already related, the spines of this class, in the state of petrifaction, are very rarely found in attachment with their shell. The first genus of this class, *Sudes villarum*, Stakes, is divided into three species: 1. *lævis;* 2. *nodosa;* 3. *granulata* and *striata;* 4. *torosa, &c.* Of the first of these species, I have not, to my recollection, seen a specimen; the glass making some configurations appear on the surface of all which I have examined of this genus: nor have I seen any of the second species, simply knobbed, the lens generally showing striæ also.

Of the third species, granulated, there exist many varieties; among which, indeed, are several apparently deserving of being considered as distinct species. Plate IV. Fig. 3, represents a cylindrical species, with denticulated rings, which is adherent to its shell, by which we discover that it belongs to one of the *Cidares papillatæ.* This spine is capitated; and, if it were not in a slight degree tumid at its commencement, might be considered as completely cylindrical. It is surrounded by eight rows of denticulated granulæ, the surface between which is minutely striated. In one specimen which I possess, these spines, very little superior, as to thickness, to those which are here represented, are full five inches and a half in length.

Of one variety of the torose, or knobbed sudes, a fragment is represented Plate IV. Fig. 5;—and now take a view of Vol. I. Plate VI.

Fig. 29, where you will have one instance of the strange, and even absurd errors, to which we are liable in these pursuits. A specimen, not indeed so well defined, is there given as part of the branch of a tree. To mistake the spine of an echinus for the branch of a tree, you may say, is pretty well; but this is trifling—I will now confess to you, that in the same plate, we both narrowly escaped the misfortune of having part of the tusk of an elephant introduced as part of the stem of a tree. I mention these circumstances, to impress on your mind the great chance of error in these pursuits, from the obscurity of specimens and the similarity of appearances, in even most different bodies. But to return :—The fossil just mentioned, Plate IV. Fig. 5, is a very curious variety of this species, *torosa*, from Giengen, in Swabia, being the compressed serrated spine which is mentioned and figured by Andrea and Leske. At its inferior termination, part of its articulating head is yet to be seen. Thence it assumes a compressed triquetral form, beset both on its edges and faces with denticulated noduli. This is the *Bacolo di santa Paulo* of Scilla, Tab. XXIV. Fig. 2. Representations of fragments of knobbed spines are given in most writers on this subject.

No fossil specimen of the genus *Sudes fortalitiorum*, pallisadoes, has, I believe, been yet known: I shall therefore be under the necessity of offering my observations on such fossils more at large, than the space, to which I find myself limited, has allowed me to treat of the former species.

The genus *Sudes fortalitiorum*, pallisadoes, is divided by Klein into two species, the plain and the variegated with bands. For an instance of the former, he refers us to Rumphius, Tab. XIII. D. D. D.; and, of the latter, he gives figures of twenty-two varieties, *de Aculeis echinorum*, Tab. XXXIV. Of the spines of this genus, he observes, the substance of which they are formed is very different from that of which the spines of all the other genera are composed. Whilst all those belonging to the class *Acicula*, and to the genus *Sudes villarum*, are formed of a substance which has a spathose appearance, those belonging to the *Sudes fortaliti-*

orum, or pallisadoes, are composed of a porous substance, in consequence of which they do not sink in water as those of every other genus do.

Among the numerous riddles which the admirers of fossils have to solve, there has been hardly any one more involved in puzzle than the original nature of the belemnite. A considerable progress had, however, been made in removing the mystery, when fresh difficulties started, in consequence of the peculiar appearances discovered in some fossils, which were sent to Klein by his friend Fischer, from Studtgard.

These bodies, although of a dark colour and striated from the centre to the circumference, and generally considered to be belemnites, were, in the opinion of Klein, the spines of echini. *Descriptiones Tubul. Marin.* p. viii. To this opinion he was led by their figure, their seeming spathose substance, and by their striæ concentering in a line passing longitudinally through the centre of the body, in which no trace of a canal was observable. Led by the examination of these bodies, which bore a resemblance so strong both to belemnites and to the spines of echini, he formed these, as it will appear, just conclusions:—That all fossils, resembling belemnites in their substance and figure, are not to be referred to belemnites; that all belemnites cannot be considered as spines of echini; and that the substances naturally constituting the belemnite and the aculeated, if not all the spines of the echinus, were such, as to be capable of undergoing the same kind of change. The fossil figured by Lhwydd, *Lithoph. No.* 1702, Tab. XXI. as *Belemnites minor cinereus ari pistillum referens;* the shelled belemnite of Grew, *Rarities of Gresham College*, Pl. 20; *Belemnites sulcatus niger major*, of Langius, *Hist. Lap. Helv.* Tab. XXXVII. Fig. 3; *Utrinque perquam acuminatus* of Baier, *Oryct. Noric.* Tab. I. Fig. 7; and others similar, he conceives, should be considered as spines of echini, and similar to those which he received from Studtgard: but those fossils which possess the conical cavity, the canalicula, and the alveola, he thinks, must still remain among the belemnites, *Descript. Tub. Marin.* p. 9, &c.

How far he was led in his suspicions, respecting these bodies, may be inferred from the following remarks:—" Neque diffitebimur, pro-

babilem esse conjecturam illorum haud levibus suffultam ratiociniis, qui belemnitas prussicas omnes, proprie lyncuriorum nomine insignitos, pro radiis animalium marinorum hactenus incognitorum reputant: quæ animalia, si non ad classem echinorum pertinerent, proxime tamen ad echinos accederent; nec deessent rationes, quæ difficultates a cavitatibus conicis, rimis alveolisque petitas sufficienter removerent; et quæso, quid tum amplius obstaret, *quin omnes Belemnitæ, Radii,* vel *Echinorum* vel *similium animalium marinorum forent!* In præsenti propositi nostri non est, aliorum causam agere: nobis incumbit ut claviculis, quas læves nuncupamus, patrocinemur, ita ut vix sufficiens ratio dissentientium appareat, ob quam illæ a radiorum echinitorum familia removeantur, et Belemnitarum classe inscribantur." *De Acul. Echin.* p. 54. He then proceeds to show, that among the dactyliform bodies, assumed to be belemnites, there are some, one of the extremities of which would apply exactly on the papillary protuberance of an echinus; and quotes the authority of Rumphius for the fact of the pallisadoe-like spines, scattered on the sea-shore, passing into a spathose substance.

It is with much pleasure that I find myself able, not only to confirm the observations made by Klein, but to point out the probable circumstance on which the perplexing ambiguity with respect to these bodies has depended. It appears, that the original matter of the pallisadoe-like echinal spine, and that of the belemnite, are both of such a nature, that on impregnation with a fluid holding carbonate of lime, in solution, they become a spathose substance, similar in colour and in form of crystallization:—a fact which, I trust, will be found to assist very much in making out the original nature of that curious substance, the belemnite.

The echinital spines which are found in chalk, are known by the chalk-diggers by the names of files, and chalk bottles: by the former, are meant the striated and prolonged cucurmerine *claviculæ;* and by the latter, those which are of an olive form. The belemnites have also, from early times, been distinguished by them as *pencils.* About two years since, among the chalk fossils which I had obtained from

Kent, were several pencils; and among them one, which, when cleared of the chalk, and carefully examined with a lens, I could plainly perceive was not only not a belemnite, but a complete pallisadoe-spine, possessing a perfect circular articulating cavity, and a grained surface, somewhat resembling the manufactured surface of seal-skin. Like most of the recent spines of this genus, it is of a triquetral form, at the end which is attached to the shell: but, unlike all those figured by Klein, it not only soon becomes larger and rounded, but terminates in a rounded cone. Its colour, at its articulating end, is of a very light fawn colour, which shades off to nearly white, at about one third of the length of the spine, the remaining part being again of a fawn colour, but much darker than that in the other part of the spine.

As a collector, I highly estimated a fossil, which I had not hitherto known to exist, and consequently treasured it with some care. But comparison with some specimens of the Folkstone belemnites, which possess somewhat of a similar form with that of this fossil, and at the same time the transparency of the Prussian fossils, which, although generally regarded as belemnites, had been suspected by Klein to be echinital spines, induced me to suspect a similarity of substance in both fossils. To determine this, I broke the fossil spine in two, and was astonished to find its substance exactly agreeing with that which is constantly found in belemnites:—a dark brown spar, with striæ radiating from the centre, and intersected by concentric circles.

Having thus got rid of this erroneously assumed mark of distinction, the brown radiating spar, and ascertained that a body, indisputably an echinital spine, had, by its mineralization, been rendered similar in its substance to belemnites; and having thereby established the position of Klein, that every body possessing a similar structure with the belemnite is not therefore to be considered as one of those fossils, we are absolutely left without any distinctive character, by which, in many instances, these fossils can be separated. It is true, that we sometimes have, on the one hand, as in the specimen just

spoken of, not only the articulating termination, but so much of the colour and surface preserved, as determines its echinital origin; and, on the other hand, we have the concamerated shell, or the alveola, which contained it, evincing the fossil to be a belemnite. But much more frequently we meet with fossils, in which, from having been broken, rubbed down, or otherwise injured, these parts are entirely removed, and their figure so altered, that it is no longer possible to determine in which class of fossils they are to be placed. The discovery of this specimen induced me to examine, with more care, those fossils in my possession, which had been hitherto regarded as belemnites; and I was much pleased at soon perceiving that many, which I should before, without hesitation, have termed belemnites, were in all probability spines of echini. In three specimens, this origin was indubitable. Plate IV. Fig. 4, shows a hard and heavy spathose specimen; which although, from its form, I had often suspected to be a fossil sudes, I never could before assert it, in contradiction to the opposite opinion of many very excellent fossilists. Its triquetral form, extending through three fourths of its length, and insensibly gliding into the rounded conical termination, with something more than a fancied resemblance in colour, determined it, in my opinion, to have been originally an echinital spine, although the further proof of its articulating termination is, by accident, destroyed. Plate IV. Fig. 19, represents a small specimen, in chalk, which appears to be a fossil spine of the same species with the preceding, but more rounded and fusiform: a small annular mark, at one end, shows, indisputably, its point of articulation.

The spine, Plate IV. Fig. 14, hitherto supposed to be a belemnite, is of a species, not, I believe, described. The inferior extremity, though somewhat crushed, still yields marks of its having there had its articulating surface. It is rendered very different from any belemnite or echinital spine which I have ever seen, from its surface being pierced with numerous small, but distinct, and somewhat regularly disposed, foramina.

Of the class *Spathula*, in which are comprised small flattish spines,

dispersed, in some species of echini, among the larger and more characteristic spines, I do not know of the existence of any fossil species; neither do I find any information respecting any fossils of the fourth class, *Radiolus coronatus*, figured by Klein, Tab. XXXII. K.; and by Scheuchzer, *Physic. Sacr.* Tab LVI. The figure, indeed, of this spine, gives rather the idea of its being a spine of the genus *Sudes fortalitiorum*, which has suffered injury, and has been repaired by the powers of the animal.

The very curious spine, Plate IV. Fig. 12, from the neighbourhood of Verona, is referable, I conceive, to this class, or to *Sudes villarum serratæ compressæ*. I am entirely ignorant of the echinus to which it belongs.

The class CLAVICULA contains many spines, which are exceedingly interesting in their forms. The first species, termed *Glandaria*, from the supposed resemblance of these bodies to acorns, are divided into those which are smooth, and those which are granularly striated. Two of the latter, of different sizes, are represented Plate IV. Fig. 9 and 11. No echini, recent or fossil, have been found, to which these large glandiform bodies are known to belong.

Plate IV. Fig. 1, 18, and 21, may be regarded as those varieties of this species, which formerly were considered, from their figure, as petrified olives, or *Lapides Judaici*. Their recent analogue is still unknown; nor was it, until of late years, that it was known to what genus of fossil echini these bodies belonged.

This circumstance was first ascertained and made known in the highly interesting travels of M. De Luc, who discovered one of these clavated spines attached to a portion of the shell. Tom. IV. p. 467, Tab. XII. The echinite found by M. de Luc was calcareous, but filled with and imbedded in flint. Another specimen, very nearly similar to the foregoing, is figured and described by Andrea, *Lit. Helvet.* p. 267. This specimen was found in the mountain named Randerberg, in Switzerland. A specimen of this kind, in flint, from Kent, is repre-

sented Plate IV. Fig. 21, with one of the spines lying close to the papilla on which it had been fixed. In this specimen may be seen the characters of the echinus. This, it is evident, is a species of *Cidaris papillata ;* but differing from any which has been described, in having the articulations of the assulæ much more concealed by the granular surface, which is extended from papilla to papilla. In another specimen, Plate IV. Fig. 1, in chalk, four of the spines are still adherent; and in another, in which several spines and two of the larger areæ are imbedded in chalk, the particular character of this shell is also plainly manifested. In another flint specimen from Pangbourn, in Berkshire, the spine is somewhat different, the longitudinal grooves being deeper, and the denticulæ more distinct.

The origin, therefore, of the *Lapides Judaici* or petrified olives, as these stones were formerly considered, is therefore now determined; and the species of echinite also, to which they belong, is completely ascertained.

I am indebted to that accurate observer of nature, Mr. Sowerby, for a very ingenious suggestion, as to the cause of a peculiar variety of figure which sometimes occurs in these spines. They are sometimes seen more than usually tumid and irregularly rugose: this he imputes, and I am assured of his being right, to the spine having suffered from disease.

The second species, *Cucumerinæ,* is divisible into several varieties, in which, although the cucumber form is preserved, very considerable differences are observable. In some, the surface is neither striated nor granulated; but irregularly and slightly nodular. But the surface in general possessed by these bodies, is formed by small granular or denticulated projections, disposed in regular rows. Plate IV. Fig. 2, 6, 8, 15, 16, and 17.

Plate IV. Fig. 15, is one of the cucumerine species of the largest size; and at Plate IV. Fig. 2, is one of the larger areæ of one of the mammillated echinites, with a narrower spine of this species attached to it. These bodies, whose origin was so long a subject of such vague

conjecture, that by some they were supposed to be white pepper in a state of petrifaction, may also now be considered as belonging to this genus of echinites.

The cylindrical and longitudinal sulcated body, Plate IV. Fig. 13, is sometimes found among the fossils of Sheppey Island. Its figure is undoubtedly ambiguous, it having some appearance of a small branch of a tree; I, however, entertain very little doubt of its being part of an echinital spine.

The small bones and teeth of the echini are sometimes found among the fossil remains of these animals. This has been doubted by some; but I have no hesitation in saying, that I have some of these fossils from Switzerland.

LETTER VI.

FOSSIL SHELLS.....ARRANGEMENT OF LAMARCK ADOPTED.....CHITON..... PATELLA.....FISSURELLA......EMARGINULA.....CREPIDULA.....CONCHOLEPAS....CALYPTRÆA....CONUS....CYPRÆA....OVULA....TEREBELLUM.... OLIVA....ANCILLA....VOLUTA....MITRA....COLUMBELLA....MARGINELLA .....CANCELLARIA.....NASSA.....PURPURA......BUCCINUM.....EBURNA..... TEREBRA...DOLIUM...HARPA...CASSIS...STROMBUS...PTEROCERA.. ROSTELLARIA...MUREX...FUSUS...PYRULA...FASCIOLARIA...PLEUROTOMA.

NOTWITHSTANDING the great degree of judgment displayed by the illustrious Linnæus, in his systematic arrangement of shells, it does not appear to be proper to adopt his divisions in the present work. It must, I believe, be admitted, that many of his genera are too comprehensive; added to which, since the forming of his classification, several shells have been discovered, possessing characters which will not allow them to be placed under any of his genera. The latter circumstance has indeed

taken place to such an extent with respect to fossil shells, as to have rendered the formation of a new classification absolutely necessary.

This task the celebrated Lamarck has accomplished with such ingenuity and care, as to give him a strong claim on the gratitude of every lover of science: and, as was exceedingly desirable, he has, by his classification, secured the admission of all those shells which are found in a mineralized state*.

The genius and accompanying zeal, possessed by this philosopher, has led him fully to avail himself of every opportunity of extending his observations; and, happily for science, these opportunities have been afforded him in a most singular degree. His situation, as professor of zoology, and particularly in the departments of insects, shells, madrepores, &c. with the superintendance of, and unrestrained access to, the Museum of Natural History, must have furnished him with unparalleled opportunities of information.

The fossil riches of the country too, surrounding Paris, particularly as to shells, exceed those, perhaps, of any other tract of a similar size. At Courtagnon, near Rheims, an enormous bank of fossil shells is open, in different parts; among which are very few that were known, or that had been described, until they had been subjected to the examination of Lamarck. At Grignon, about seven leagues from Paris, fossil shells are so exceedingly abundant, that M. Defrance, by his indefatigable industry, has collected at least five hundred distinct species, more than three fourths of which have never been before described. These fossil shells, discovered by M. Defrance, are most correctly copied, under the directions of the professors of natural history, and the drawings are carefully preserved in the Museum, for the purpose of ready examination.

It is true that this bank of shells appears to be exactly correspondent with that which exists in Hampshire, the fossils of which have been so

* This part of Lamarck's labours commences in *Les Annales du Museum d'Histoire Naturelle, Tome* I. *p.* 308, and is continued through the succeeding volumes.

well illustrated by the labours of Brander and Solander. But, whilst the Hampshire fossils are generally broken, from the very soft and fragile state to which they are reduced by the mud in which they are involved, the fossil shells of France are found in the highest state of preservation: and hence numerous species, which can in this island be hardly ever obtained, are there found in a perfect state. How assiduously and successfully M. Lamarck has employed these several advantages, will be manifested by the arrangement he has formed, and the important observations which he has made.

Of the testaceous molluscæ he considers the cephalous, from being the most perfect, as being proper to form the first order. With the exception of the chiton, all the other cephalous conchyliferous molluscæ, he observes, are simply univalves, whilst the acephalous are inclosed in two or more valves.

Genus I. *Chiton.* An oblong-elliptical, convex, multivalved shell; with transverse valves, partly lying over each other, in a row, on the back of the animal.

The only notice which I find taken of the fossil remains of this animal is by Lamarck, who states, that the separated valves only are found at Grignon. From this separation of the valves he finds it difficult to determine to what species these fossil remains belong, but conjectures that it is to *C. octovalvis.* I am happy in possessing a very perfect specimen of the fossil testaceous covering of this animal from Grignon, and in its confirming the opinion of M. Lamarck, as to the number of its valves, which are eight.

This fossil is in so high a degree of perfection, as to have made me at one time suspect its being only decomposed by exposure to the air; but an examination with a lens showed not only the adherent matrix, but two species of extremely minute fossil serpulæ fixed on its convex surface. This fossil is represented Plate V. Fig. 5, and by its side are sketches of the minute adherent serpulæ.

Lamarck, adopting certain constant characters, which seem to

warrant the separation, has divided the shells forming the Linnæan genus *Patella*, into the five next following genera.

II. *Patella.* A shield-formed or subconical, and not spiral univalve, without perforation or marginal fissure.

It appears that nine species have been found, in a fossil state, in the neighbourhood of Paris: *P. elongata, P. dulcis, P. scutatella, P. dilatata, P. cornucopiæ, P. spirirostris, P. retortella, P. pennata,* and *P. squamæformis.*

The patellite, Plate V. Fig. 21, for which I am indebted to the kindness of John Hawker, Esq. of Dudbridge, in Gloucestershire, is from the stone quarries near Minchinhampton. It is nearly circular, rising obliquely into a depressed distorted cone, and is marked with longitudinal radiating undulated rugæ, intersected by transverse lines of growth. It is now completely spathose. Its matrix is a light calcareous stone, formed chiefly of *Oolithi,* mixed with numerous minute shells.

In the immense shelly cliffs of Harwich and of the neighbouring coast, I have found an acuminated, slightly striated patellite, in every respect resembling *P. ungarica,* Linn. The longest diameter of a beautiful and perfect specimen of this fossil, is full two inches and a half. In the same cliff I find a patellite, which appears to correspond very closely with *P. lævis fusca,* List. and another which approximates to *P. spirirostris,* Lam.

P. cornucopia, Lam. is a beautiful species. Among the specimens which I possess is one which, although it has the general character of this species, is much narrower than those depicted by Lamarck; but I am not competent to determine whether it should be considered as a distinct species, or only as a variety.

Among the specimens I have from Grignon is *P. dilatata,* Lam. and another, resembling it in form, but very distinctly marked with longitudinal and transverse rugæ, much like the Gloucestershire limpet. I observe the same characters in another fossil patella from the valley of Ronca, in the Veronese.

This genus presents the best place in which I can notice the remarkable limpet-like shell described by Da Costa, who never saw but four that were entire, or nearly so. He places it among the patellæ; and says: "These limpets are very large, and, like the *Concholepas*, resemble a single shell of a bivalve. They seem to be of two kinds, and are more irregular than that shell; and, instead of being sulcated lengthwise, are circularly wrought, or in a transverse manner, with very high irregular ridges, not thickly, but rather thinly, set. The shells are very thick: one sort is high or copped, the other is broad or flattish." *Elements of Conchology*, p. 142. The specimens which I possess of this fossil are not sufficiently illustrative of its form. I have, however, given a figure of one of them, which was found at Pangbourn, in Berkshire, Plate V. Fig. 3.

III. *Fissurella.* A buckler-formed univalve, without spire: the vertex perforated, with an ovate or oblong opening.

The species which I have obtained from the Essex cliffs nearly resemble the *F. labiata*, Lam.

IV. *Emarginula.* An obliquely conical univalve, the vertex inclined, and the posterior margin slit or notched.

I have repeatedly found a species of this genus in the Essex cliff, which, in its elegantly reticulated or cancellated surface, its reclined vertex, and its size, agrees with *P. fissura*, as figured by Pennant, Plate XC. Fig. 152; and by Lister, Tab. DXLIII. Fig. 28, who describes it as *Patella exigua, alba, cancellata, fissura notabili in margine.*

Three species are described by Lamarck, *E. costata*, *E. clypeata*, and *E. radiola.*

V. *Crepidula.* An oval or oblong vaulted univalve, with its apex inclined to one end, and its cavity partially divided by a horizontal plate.

VI. *Concholepas.* An oval vaulted univalve, the apex inclined to the left side, with two teeth and a sinus at the base of the right edge.

No shell of either of these genera appears to have been found fossil.

VII. *Calyptræa.* A conoidal univalve, with the apex erect, entire and rather pointed, the cavity furnished with a spirally convoluted lip or diaphragm.

It is to this genus, as *Calyptræa trochiformis*, that Lamarck refers the fossil which Solander, in consequence of its possessing a kind of spire, has considered as a trochus, denominating it *Trochus apertus;* and in another state, tuberculated and more depressed, *Trochus opercularis. Fossil. Hautoniens.* Tab. IX. Fig. 1, 2, 3. These are found in the Hampshire cliffs, with the other fossils, figured in the work of Brander, just referred to. They are also found, in a very fragile state, between Woolwich and Blackheath, in the parish of Plumstead, in Kent. Lamarck also describes another shell, found with the former at Grignon, which he considers as a distinct species, *C. crepidularis*, from its not being completely orbicular, and from its having its spire bent downwards, as in the *crepidulæ.*

Another species of this genus, Plate V. Fig. 10, found in the Essex cliffs, appears exactly to agree, in its form, with *Patella sinensis*, Lin. as figured by Lister, Tab. LXVI. Fig. 39. It forms a depressed cone, with a circular base and mammillary apex, and should perhaps be distinguished as *Calyptræa sinensis.* Some specimens of this shell, which I have obtained from the neighbourhood of Harwich, have their upper part completely invested with a mineralized spongy, or alcyonic, mass.

VIII. *Conus.* A turbinated, convoluted, inversely conical univalve; the aperture long, narrow, toothless, and not contracted at the base.

Of the genus *Conus*, Lamarck describes four species, as found at Courtagnon and Grignon:—*C. antediluvianus*, *C. deperditus*, *C. turritus*, and *C. stromboïdes.*

C. deperditus, distinguished by its channeled spire, I have also obtained from the Veronese territory. From this place I also obtained the fossil shell, Plate V. Fig. 1, which very nearly accords with

C. stromboïdes, Lam. being subfusiform and transversely striated, with a nodular spire: the nodules, however, appearing to be more projecting, and turns of the spire more acute, than in the shell described by Lamarck.

IX. *Cypræa.* An ovate convex univalve, with the margins involuted; spire small, and nearly covered over; the opening long, narrow, and toothed on both sides.

When we consider that the markings of the recent shell of the genus *Cypræa* frequently determine the species, and that these markings are lost in the mineralization of the shell; and when it is also considered, that even the forms of the shells are considerably different, at different periods of their growth, we must see how difficult it will often be to determine whether any specific analogy exist, or not, between the recent and the fossil shell.

Lamarck describes three fossil species: *C. pediculus*, *C. inflata*, and *C. sulcosa*, as being found at Grignon.

I have found several of this genus in the Essex cliff, which I am disposed to refer to *C. pediculus*. The striæ must, however, be acknowledged to be finer and closer than in the recent shell. They are perhaps nearer allied to *C. costata*, Linn.

The sulcated specimen, Plate V. Fig. 24, from Verona, appears to merit, from its size, the being considered as a species distinct from any at present known. Other species, with a smooth surface, are also obtained from the Veronese territory.

X. *Ovula.* A tumid univalve, more or less elongated in a point, at the ends; the edges involuted, and the opening longitudinal, and without teeth on the left side.

Bruguiere separated from the genus *Bulla*, of Linnæus, the *Bulla ovum*, *volva*, &c. those shells which, having their edges rolled inwards, being elongated at their extremities, and not being dentated on their left side, seemed to constitute a distinct genus: these he has, there-

fore, collected under this genus, of which I do not know that any have been found fossil.

XI. *Terebellum.* A convoluted univalve, with an acute apex. The opening longitudinal, narrow upwards, notched at the base, and toothless. The columella truncated.

Bulla terebellum of Linnæus is also separated from the genus *Bulla* by Lamarck, who observes that it approaches nearer to *Strombus* than to *Bulla;* it differing from the latter in the notch at the base of its opening, and by the columella being, as it were, truncated at its lower part, as in *Strombi.*

A fossil shell of this genus is figured by Brander, *Fossil. hauton.* Tab. I. Fig. 29, *a.* and Tab. VI. Fig. 75, as one of the Hampshire fossils, and named by Solander, *Bulla sopita et volutata.* It is a thin subcylindrical shell, with no spire. A shell of the same species, named by Lamarck *Terebellum convolutum,* is found in considerable number at Grignon; and, notwithstanding their very fragile nature, many are found in a perfect state, proving that they must have lived in the region in which they are found. The recent analogue of this shell is not known. Another species, *T. fusiforme,* is also found in the environs of Paris.

XII. *Oliva.* A subcylindrical univalve, notched at its base. The turns of the spire separated by a channel. The columella striated obliquely.

The genus *Voluta,* of Linnæus, comprehends many shells, the characters of which certainly require their separation into other genera. This has been accomplished by Lamarck, with much care. *Oliva* is a genus which he found necessary thus to form, Linnæus having considered all the olives as only varieties of one species of volute, which he named *Voluta oliva.*

Lamarck describes three species of this genus found in the neighbourhood of Paris: *O. canalifera, O. mitreola,* and *O. Laumontiana.*

Shells of this genus, but not in a state to allow of their species being determined, are also found in the Vincentine territory.

XIII. *Ancilla.* An oblong subcylindrical univalve, with a short spire, not channeled: the aperture effused, and its base slightly notched. A thick oblique fold at the base of the columella.

The separation of these shells from those of the genus *Oliva*, appears to be hardly necessary; the only material difference being, that those which he places under the latter genus have not the turns of the spire separated by a channel, as is the case with those which are allotted to the former genus. Four species of these shells are found at Grignon and Courtagnon: *A. buccinoides*, *A. subulata. A. olivula*, and *A. canalifera.*

The characteristic of the genus *Voluta*, of Linnæus, the folded columella, is doubtlessly much too general, and belongs to many shells which require to be arranged under separate genera. Bruguiere, in the first place, separated those shells which were not notched at their base: since which, Lamarck has taken from this Linnæan genus such shells as appeared to him to be capable of forming the new genera, *mitra*, *colombella*, *marginella*, *cancellaria*, and *turbinella.*

XIV. *Voluta.* An ovate subventricose univalve; the apex papillary, and base emarginated. The columella plicated: the inferior plicæ being largest or longest.

In this genus are comprised, *Voluta cithara*, Lam. *Encyc.* Tab. 384, Fig. 1; *Citharædus*, Chemn. Vol. XI. p. 297, Tab. 212, Fig. 2098, 2099. This shell is remarkable for the beautiful polish which it retains. *V. spinosa*, Lam.; *Strombus spinosus*, Linn.; *S. luctator*, Brand, *Foss.* Fig. 65, List. Tab. 1033. This shell is singularly beautiful, retaining not only its perfect form and its polish, but its orange-coloured transverse stripes. *V. muscialis*, Lam. is *Str. luctator*, Brand, Fig. 65. In *V. muricina* and *V. costaria*, of Lamarck, is instanced the ambiguity so frequently observable in fossil shells: the general form of *murex* in the former, and of *fusus* in the latter of these shells

are discoverable, but blended with the generic characters of *Voluta. V. bicorona*, Lam. is *Strombus ambiguus*, of Brander; and *V. crenulata*, Lam. is Brander's *Murex suspensus.* Lamarck describes seven more species, which are found in the vicinity of Paris: *V. lyra*, *V. harpula*, *V. labrella*, *V. bulbula*, *V. depressa*, *V. variculosa*, and *V. mitreola.*

The most rare shell of this genus found in this island is, I believe, the fossil volute of Harwich, Plate V. Fig. 13, which I have chosen as a specimen of this genus. No corresponding recent shell appears to be figured. Langius gives the figure of a cast, *Hist. Lapid. Fig.* p. 112, Tab. XXXIII. Fig. 3, which certainly bears a very close resemblance to this fossil. A very faithful representation of a very imperfect specimen of this shell is given in the Appendix to Dale's History of Harwich, Plate X. Fig. 14, p. 289, excepting that the plicæ are too large.

The ovate fusiform figure of this shell gives it an appearance somewhat resembling some recent shells, but by no means sufficient to warrant the supposition of an identity of species. A shell apparently of this species, invested with pyrites, has been found in Mr. Trimmer's grounds, at Brentford.

A very fine fossil shell, bearing much of the form of this volute, is found in some parts of Yorkshire, I believe in the neighbourhood of Whitby. This shell is so perfect, and its colours are so well preserved, that a specimen of it, having fallen some years since into the hands of Mr. George Humphries, he was deceived into the opinion of its being a dead shell; and being satisfied that it was of a species which was entirely unknown, he cleaned it and polished it as a recent shell: and was not undeceived, until at a subsequent period he saw another specimen, by which he was enabled to ascertain its being really a fossil.

XV. *Mitra.* A subfusiform univalve, with a pointed apex, a notched base, and no canal: the columella plicated; the inferior plicæ being the smallest.

The lower plicæ being smaller than the others, and the apex pointed, distinguish these shells from the volutes. Lamarck describes thirteen

fossil mitres as having been found in the neighbourhood of Paris: *M. crebricosta, M. monodonta, M. marginata, M. plicatella, M. labratula, M. mixta, M. cancellina, M. terebellum, M. fusellina, M. graniformis, M. mutica, M. elongata,* and *M. citharella.*

XVI. *Columbella.* An oval univalve, with a short spire; the base of the opening more or less notched, and without canal. A swelling on the inner part of the right side. Folds, or teeth, on the columella.

This genus is exemplified in *Voluta mercatoria,* Lin. *List. Conch.* Tab. 824, Fig. 23. No shells of this genus have been found fossil by Lamarck, nor am I aware of any having been found in this island.

XVII. *Marginella.* An ovate-oblong, smooth, univalve, with a short spire. The lip thickly marginated on the outside. The base of the opening but slightly notched; the columella plicated.

Lamarck particularizes three fossil species; *M. eburnea, M. dentifera, M. ovulata.* Plate V. Fig. 14, represents *M. eburnea,* from Grignon. I am not aware of any of this genus having been found fossil in England.

XVIII. *Cancellaria.* An ovate or subturrated univalve, with the lip sulcated internally. The base of the opening slightly channeled; and, in some, almost entire. Sharp, but compressed plicæ on the columella.

The compressed, but sharp plicæ, on the columella, distinguish these shells from those of *Nassa* and *Purpura;* whilst the corrugated lip detaches them from the *mitræ, marginellæ,* &c.

Plate V. Fig. 8, represents a very interesting shell of this genus, from Courtagnon. An ovate shell, with a long spire; with thick angulated ribs, muricated about their centre, and divided by fine transverse striæ; the columella with three plicæ; the opening nearly entire, being contracted rather than notched at its base.

The observations made by Lamarck on another species of this genus, *C. volutella,* a turreted varicose shell, having numerous longitudinal ribs, with nearly obsolete transverse striæ, and a short, scarcely notched, tail, in a great measure apply to the shell here figured.

This shell, he says, is so singular, that I hesitated in determining its genus. It has the prominences of a murex, the folds of a volute, and the general appearance, with the notch, of a buccinum; and yet, its other characters and agreements, determine its place to be among the cancellariæ. He describes two species of this genus as fossils: *C. costulata* and *C. volutella.*

XIX. *Nassa.* An oval univalve, the opening terminating inferiorly with an oblique notch, a little channeled; the base of the columella hiding the notch, in part, and appearing to be obliquely truncated.

It does not appear that any fossil shells of this genus are known.

XX. *Purpura.* An ovate univalve, its surface being rather rough with spines or tubercles; the aperture notched, and slightly channeled in the lower part; the columella naked, flat, depressed, and terminating in a point at the base.

Purpura lapillus, Buccinum lapillus of Linnæus, is the only species found fossil by Lamarck.

XXI. *Buccinum.* An ovate elongated univalve; opening oblong, notched in the lower part, and with no canal; columella convex, full and naked.

Bruguiere reduced the Linnæan genus *Buccinum,* by taking from it the genera *terebra* and *cassis.* Lamarck has carried this reduction still further, by forming, with some of the shells, the genera *tonna, harpa, nassa,* &c. Those shells only are now disposed by Lamarck, under the genus *Buccinum,* as possess the above characters.

Buccinum Stromboides, Lam. from Grignon, is distinguishable by its full slightly ribbed lip, which forms somewhat of a stromboidal sinus at its attachment to the spire. This shell in general possesses a considerable polish: and, as in this specimen, Plate V. Fig. 20, it frequently shows some of its original colour. It appears that six species have been found in the environs of Paris: *B. stromboides, B. striatulum, B. terebrale, B. decussatum, B. bistriatum,* and *B. clavatulatum.*

B. bistriatum, and *B. decussatum*, of Lamarck, are, I suspect, both found in the Essex cliff.

XXII. *Eburna.* An oval or elongated univalve, the right edge very entire ; the opening oblong, and notched at the bottom ; the columella umbilicated, and slightly grooved at its base.

Buccinum glabratum, Linn. Lister, Tab. 974, Fig. 9, is given as the type of this genus by Lamarck, who mentions this genus only in his *Systeme des Animaux sans vertebres*, not noticing it at all among the fossils of the environs of Paris. A shell, however, exists among the Essex fossils, which, except in having the columella hardly umbilicated, seems very nearly to approximate to this genus, and to the particular shell *B. glabratum*, which is given as its type.

This shell, which I will venture to call *E. glabrata*, is figured Plate V. Fig. 25.

XXIII. *Terebra.* A turreted and subulated univalve : the opening short, and notched in the lower part. The basis of the columella twisted.

Two species of this genus are found in the environs of Paris : *T. plicatula* and *T. scalarina*. *T. plicatula* is represented Plate V. Fig. 7.

XXIV. *Dolium.* A subglobular ventrose univalve, ribbed circularly across ; the right lip dentated or crenulated through its whole length. The opening oblong, ample, and notched at the bottom.

No shell of this genus appears to have been found fossil.

XXV. *Harpa.* An ovate, ventricose univalve, with longitudinal compressed ribs, terminating superiorly in an angle or a point ; the opening notched in the lower point, and with no canal : the columella smooth, with an acute base.

This genus comprises those shells which had been referred by Linnæus to the genus *Buccinum*, and entirely to the species *Buccinum harpa.* These shells, like most of those which have been already mentioned, are sea shells, and are inhabitants of the warmer climates. The only shell which I have of this genus, is one which, although it

possesses sufficient characters to mark its genus, is too much injured and involved in pyrites, to allow its species to be determined. Its parallel compressed, and obliquely inclined ribs, with the pointed angle at their summit, and the smooth columella, completely, however, determine its genus. This shell was found in a stratum of dark pyritous clay, at Brentford, on the premises of Messrs. Trimmers.

Lamarck describes but one fossil species, ***H. mutica***, as found near Paris.

XXVI. *Cassis.* A gibbose ventricose univalve; the aperture longitudinal and subdentated, and terminating in a short reflected canal. The columella plicated in its lower part; and the left lip flattened, and forming a ridge on the body of the shell.

Cassis carinata, Lam.; ***Buccinum nodosum***, Soland. and Brander, is a beautiful fossil species of this genus.

A very beautiful fossil shell is found in a hill in Arragon, at above a hundred feet in height. The nodulous rugæ, on the left side, at the lower flattened part of the columella, the dentated right lip, the reverted sinus, and the globose cassideal form, determine its genus; whilst its transverse rounded ribs, and nodular risings on the upper part of the body of the shell, mark its species as different from any recent shell with which I have been able to compare it. It is about two inches and a half in length.

The hills of Tuscany also yield some fine specimens of this genus. One of these, about half the size of the preceding fossil, possesses most of its characters; but its spire projects more, and is formed of six turns; and the mouth contracts, in its upper part, into a sinus, between the body of the shell and the right lip. The surface of this shell is smooth. A second of these Tuscan cassidites is still longer in its spire, which is formed of seven turns, and is characterized by regular transverse circular markings. In a third, the surface is marked by lines similarly disposed, but alternately larger and smaller; and the teeth of the right lip are very prominent and distinct. The general

characters of these shells very much accord with *Buc. recurvirostrum*, Linn. as figured by Lister, Plate 1016, No. 75.

These shells were found by Mr. Strange in the sandy hills of Tuscany; and were introduced, with some other curious fossils, in two plates, engraved for him by Antonio Gregorio, from drawings of Giuseppe Menaboni. In the description of these plates he designates these shells as *Buccino-cassides*.

In one of the plates, and under the same designation, is the uncommon shell represented Plate V. Fig. 17 and 19. This also was found in the Tuscan hills; and, according to Knorr, it has also been found in Piedmont. The last turn of this shell is extremely large, when compared with the other four turns. The spire projects but very little. The body of the shell is smooth, slight traces of transverse striæ only being observable. The right lip is of considerable thickness, and dentated on its inner surface. The left lip is extended along the body of the shell, up to the termination of the right lip. The aperture in the middle part is oval, but terminates upwards, in a considerable groove, which runs between the right lip and the body of the shell; and downwards, in a short reflected canal. A thick projecting fold runs up from nearly the middle of the lip, and is inserted into the middle of the next spiral turn.

Three species have been found in the environs of Paris: *C. harpæformis*, *C. cancellata*, and *C. carinata*.

The fossil shell, I believe from France, Plate V. Fig. 23, is perhaps one of the most singular with respect to its mixture of characters. Viewed at its back, it has the general appearance of a shell of the genus *Harpa*; but in its front, its summit, its long slightly dentated aperture, plaited columella, aud widely extended left lip, show its most proper place to be under the genus *Cassis*, notwithstanding that the inferior termination of the aperture is that of a buccinum, instead of the short reflected canal of cassis; and that it has the flat broad columella of *Buccinum patulum*, Linn. or *Purpura patula*, Lam.

This shell agrees, in some of its anomalies, with the description of *Voluta depressa*, Lam.; but it seems to differ from that shell, which, however, I have not seen.

XXVII. *Strombus.* A slightly ventricose univalve, terminating at its base in a short notched or truncated canal. The lip enlarges with age, appearing like a plain, entire, and single lobated wing, with a groove in its lower part. This last circumstance appears to be particularly characteristic of this genus.

Lamarck describes but one shell of this genus as found in the neighbourhood of Paris. This is *Strombus canalis*, resembling, in many respects, the *rostellaria fissurella* of the next genus, but differing from it in having a groove on its right edge.

Fossil shells of this genus are very rare. Some of extraordinary preservation have, however, been found in the mountains of Arragon. In the Veronese also are found small alated strombi, in very excellent preservation, although very much changed in colour, apparently from ferruginous impregnation.

XXVIII. *Pterocera.* A ventricose shell, terminated inferiorly, by an elongated canal; the right edge dilating with age into a digitated wing, and having a sinus towards its base.

Strombus lambis, Linn. is the type of this genus, none of the species of which are known to me to exist in a fossil state.

XXIX. *Rostellaria.* A slightly turreted or fusiform univalve, terminating at its base in a lengthened canal, similar to a sharp beak. The lip whole or dentated, and dilated with age; with a groove contiguous to the canal.

This genus is distinguished by the sinus of the inferior part of the right edge being contiguous with the canal in the beak of the shell, which does not take place in the *Pterocerœ* and *Strombi.*

The most remarkable fossil shell of this genus is, *Rostellaria macroptera*, Lam.; *Strombus amplus*, Brander. *Brand. Foss.* p. 34, Plate VI. Fig. 76; found in Hampshire, and at Courtagnon, St. Ger-

main en Laye, &c. in France. This large and handsome fossil, so finely displayed in Brander's work, is remarkable for the size of its right lip, which is formed into a wide, round, and rather thin wing, extending from the canal at the base, over the body of the shell and a great part of the spire. All the superior part of this wing forms, at its union with the spire, a longitudinal channel-like fissure.

A fragment of a fossil shell which I possess, which from its surface appears to be from France, resembles the spire, with part of the fissure, of *Rostellaria subulata*, Lam.; *Strombus fusus*, Linn. The most common fossil shell of this genus is, *Rostellaria fissurella*, Lam.; *Strombus fissurella*, Linn. It is very abundant at Grignon. The wing is but small; it however is continued in a channeled ridge, over nearly the whole length of the spire.

Under this genus may be placed *Strombus pes pelicani*, Linn. Of these I possess some from Mr. Strange's collection, apparently French fossils, in a very good state of preservation, and which do not appear to differ materially from the recent shells.

In the Essex cliff, I once met with a shell of this family, but which differs from the preceding in having only one spur-like process passing out of the alated side. My worthy friend Mr. Francis Crow, of Faversham, has, since that, presented me with a similar, but more perfect shell, in a silicious state, which he found near that town. This shell has been also found in the Devonshire whetstone-pits, in the same silicious state; and it is remarkable that, both in Devonshire and at Faversham, these shells are accompanied by a bivalve, *Cucullæa decussata*, a shell which, I believe, has not yet been found in any other part of this island; but which is found in both these places, in the same silicious state. A representation of the Devonshire silicious rostellarite, imbedded in its matrix, is given Plate V. Fig. 11.

Among the very interesting fossils of the whetstone-pits is the minute shell, now entirely flint, represented Plate V. Fig. 2. This shell not only differs from the *R. pes pelicani*, in its having only one

spur-like process; but seems to differ from the preceding species, both in the length of its spire and of its spur. The number of turns in its spire shows that it is not a young shell of the preceding species, but that it is rather a perfect shell of a distinct species.

Lamarck describes only three species of this genus as found fossil in the neighbourhood of Paris: *R. macroptera*, *R. columbaria*, *R. fissurella.*

XXX. *Murex.* An ovate or oblong univalve, with a channeled base and varicosely tumid; rough, spinous, or fringed longitudinal and projecting sutures.

By confining the murices to the shells thus characterized, shells are excluded, with which Bruguiere and Lamarck have formed the genera *cerithium*, *fusus*, *pyrula*, *pleurotoma*, and *fasciolaria.* In the murices, the canal, neither suddenly truncated nor abruptly turned back, the columella with no fold, and the left lip of the opening always more or less apparent, always determine the genus.

Murex tripterus, of Brander, Born, and Lamarck, is found frequently fossil in Hampshire, and at Grignon, in France. *Brander, Foss.* Plate III. Fig. 79 and 80. Lamarck informs us that its recent analogue exists in the sea, in the neighbourhood of Batavia.

M. Contabulatus, Lam. is doubtless a variety of the preceding species. *M. tricarinatus*, Lam. *M. asper*, Brand. *Fossil. haut.* Fig. 77, 78, is very remarkable for the spinous projections proceeding from its frondose ridges.

The shell, Plate V. Fig. 16, is rather a rare shell in the Essex cliff. It is fusiform. The turns of its spire, which are generally six, are thinly set with not very prominent rugæ, which, with faint transverse striæ, are also observable on the body of the shell; the opening is smooth on each side, and the canal is rather patent. The rugæ, continued to the body of the shell, induce me to term this shell *Murex rugosus.*

A fossil murex is much more frequently found in this cliff, which seems to agree exactly with *M. corneus*, Linn. as figured by Lister,

Anim. Angl. Tab. 3, Fig. 4, who says it is found, but rarely, on the Scarborough coast.

The shell represented Plate V. Fig. 22, is a shell from the same cliff, of very curious structure; it appears to be *M. Erinaceus*, Linn. Its specific characters are, an oblong ovate form; the spine formed by five or six angular turns; rather obtuse longitudinal ribs, appearing as if interwoven with transverse, close, squamose, cord-like ridges; the columella slightly umbilicated, with a very small tooth-like projection; and the right lip rather denticulated.

Murex tubifer, Lam. *Murex pungens*, Brand. *Foss. haut.* Fig. 81, 82. An oval shell, terminating in a point at each end, and furnished with, generally, four ridges, beset with hollow, bent, and pointed spines, and with short tubes; and not, as they appear to be, broken spines, disposed between the spinous ridges. The fistulous spines and short tubes with which this shell is beset, render it very remarkable, and distinguish it from every other shell. It is found both in Hampshire and Grignon. A very fine specimen of this shell is represented Plate V. Fig. 15. It is said by Bruguiere, that the recent analogue of this extraordinary shell was in the late Dr. Hunter's Museum.

In this genus must be also placed the shell which is so well known by the appellation of the Essex reversed whelk, the twirls passing from the right hand to the left. This shell is figured by Lister, *Histor. Conchyl.* Tab. 950, Fig. 44, *b* and *c;* and by Dale, *History of Harwich*, Plate X. Fig. 6; and is considered as a murex, *M. contrarius*, by Linnæus, *System. Natur.* Tome I. p. VI. p. 3564. Considerable variety occurs in the surface of these shells: some are strongly marked with longitudinal linear markings, and are without any transverse markings; whilst in others transverse linear markings, single or double, are plainly seen, and no longitudinal rugæ exist. In some few I have observed these markings so determined and distinct, as almost to authorize the regarding of them as specific characters. Plate VI. Fig. 6, represents one of these shells, of rather a small size.

This shell, which sometimes reaches to full three inches in length, has six or seven turns in the spire; the last, or body-whirl, is large and globose: the left lip sometimes rising in a strong ridge; and is, as well as the right lip, very smooth on its inner side: the columella is disposed to be umbilicated, and the aperture is nearly oval, terminating in an open canal.

The original shell, with the twirls passing from the left to the right, of which the one just spoken of may be considered as a variety, has not been yet mentioned as having been found in the Essex cliff. Dale, indeed, queries whether ***Buccinum rostratum***, out of Harwich cliff, thus mentioned by Woodward, *Catalogue*, Part II. p. 37, e. 115, may not be referable to this shell: but this can hardly be supposed, from so general a designation; since, having so strongly particularized the reverse shell, it is not likely that he would have omitted to point out this as being the same shell, turning in the ordinary direction.

In the many visits which my late respected friend, Dr. Menish, paid to this cliff, he discovered two specimens of this shell, with the whirls in the ordinary direction. My repeated researches having been always unsuccessful, I purchased these shells from Dr. Menish's collection.

One of these seems to differ from the heterostrophe in not having its whirls so obliquely disposed, in the spire not being so long, in the aperture being every way larger, and in the left lip rising higher, and being larger and more detached. The other is a very old shell, and measures full five inches in length, and three in width.

A shell, which has been supposed to resemble this last-mentioned fossil, has been found on the coast of New Holland; but the columella, in this shell, is so nearly naked, as, I think, renders it specifically different. A recent shell is, however, found on the Essex coast, turning the right way, which very nearly, if not exactly, agrees, in its specific characters, with the heterostrophe.

Lamarck describes seventeen species of this genus as found fossil in the neighbourhood of Paris: *M. tripterus, M. tricarinatus, M. contabulatus,*

M. calcitrapa, *M. crispus*, *M. frondosus*, *M. clathratus*, *M. cingulatus*, *M. striatulus*, *M. cancellinus*, *M. pyraster*, *M. textiliosus*, *M. colubrinus*, *M. Viperinus*, *M. nodularius*, *M. reticulosus*, and *M. tubifer*.

XXXI. *Fusus*. A subfusiform univalve, ventricose in its middle or lower part, with a canaliculated base, and no varicose sutures; an elongated spire, a smooth columella, and the lip not slit.

This genus is formed by Lamarck of shells which were comprised in the genus *Murex* of Linnæus, and in the genus *Fusus* of Bruguiere, who had also retained in it *pyrula*, *fasciolaria*, and *pleurotoma*, with which Lamarck has formed separate genera. *Murex longævus*, Brand. is very properly disposed under this genus, by Lamarck, as *Fusus longævus*. *Murex deformis*, Brand. is also brought here as *Fusus clavellatus*. *Fusus rugosus* he considers as the same shell as *Murex porrectus*, Brand.

Lamarck has discovered, in the environs of Paris, thirty-three species of this genus which he has so much diminished: *F. rugosus*, *F. Noæ*, *F. longævus*, *F. clavellatus*, *F. aciculatus*, *F. subulatus*, *F. hordeolus*, *F. intortus*, *F. polygonus*, *F. abbreviatus*, *F. excisus*, *F. minutus*, *F. asperulus*, *F. plicatus*, *F. scalaroides*, *F. coronatus*, *F. alligatus*, *F. marginatus*, *F. nodulosus*, *F. angulatus*, *F. uniplicatus*, *F. funiculosus*, *F. heptagonus*, *F. subcarinatus*, *F. ficulneus*, *F. bulbiformis*, *F. terebralis*, *F. citharellus*, *F. lævigatus*, *F. striatulatus*, *F. biplicatus*, *F. variabilis*, and *F. truncatulus*.

XXXII. *Pyrula*. A somewhat pyriform univalve, swelling in the upper part, with no variciform sutures, and having a caudated canaliculated base and a short spire. The columella smooth, and the lip not slit.

P. lævigata and *clathrata*, Lam. approximate to *Bulla ficus*, Linn. *P. subcarinata*, Lam. has much of the form of *Voluta labrella*, but has no fold on the columella. *P. nexilis*, Lam. is *Murex nexilis* of Brander. *P. lævigata*, Lam. also agrees, I think, with No. 54, of Brander.

Six species of this genus have been found fossil by Lamarck:

P. lævigata, P. subcarinata, P. tricarinata, P. elegans, P. clathrata, and *P. nexilis.*

XXXIII. *Fasciolaria.* A subfusiform univalve, channeled at its base, without any projecting sutures, and having two or three very oblique folds on the columella.

This genus is represented by *Murex tulipa,* Linn. *List. Conch.* Tab. 910, Fig. 1, et 911, Fig. 2. No fossil shells appear to have been found, which can be referred to this genus.

XXXIV. *Pleurotoma.* A fusiform, or somewhat turreted univalve, with the lower part of the opening channeled, and the upper part of the lip notched.

The shells of this genus had been separated from the *murices*; and, on account of their form, had been disposed by Bruguiere in the genus *Fusus.* But the notch in the lip, resulting, necessarily, from a peculiar organization in the animal, fully authorizes their arrangement in a distinct genus. This separation of *Pleurotoma* from *Fusus,* as is justly observed by Lamarck, appears, indeed, to be indicated by the considerable number of species which each of these genera contains. Of this genus only, he obtained twenty-five species from the neighbourhood of Paris : *Pl. filosa, P. lineolata, P. clavicularis, P. glabrata, P. marginata, P. transversaria, P. catenata, P. dentata, P. undata, P. multinoda, P. crenulata, P. bicatenata, P. costellata, P. plicata, P. sulcata, P. curvicosta, P. furcata, P. nodulosa, P. ventricosa, P. terebralis, P. granulata, P. inflexa, P. turrella, P. striarella, et P. decussata.*

Plate V. Fig. 26, represents a beautiful species of this genus, from France.

LETTER VII.

FOSSIL SHELLS CONTINUED.—CERITHIUM.....TROCHUS....SOLARIUM..... TURBO....MONODONTA....DELPHINULA....CYCLOSTOMA....SCALARIA..... TURRITELLA....PUPA....JANTHINA....BULLA.....BULIMUS.....ACHATINA ....PHASIANELLA...LYMNÆA....PYRAMIDELLA...MELANIA...AURICULA .....VOLVARIA....AMPULLARIA.....PLANORBIS....HELIX.....HELICINA..... NERITA......NATICA......TESTACELLA......STOMATIA......CARINARIA...... HALIOTIS.....SIGARETUS.....ARGONAUTA.

XXXV. Cerithium. A turreted univalve, with an oblique opening; the base terminated by a short truncated or recurved channel, and ending upwards in a channel more or less distinct.

This genus, so plainly marked by the oblique opening, with, as it were, a reversed groove in its superior part, was formed by Bruguiere from shells possessing these generic characters, and which had been retained by Linnæus in the genera *Murex*, *Strombus*, and *Trochus*.

It is well observed by Lamarck, that, since the extreme diversity of the protuberant parts on the surface of these shells, as well as the regularity and elegance in which they are disposed, leaves hardly any possible form of which nature does not here shew a pattern, one may be permitted to say that architecture might receive from the species of this, and indeed of the preceding genus, a choice of models which might be well worthy of being employed for the embellishment of columns, &c.

In the neighbourhood of Paris only, this assiduous investigator has discovered sixty species of this genus.

C. interruptum, *C. hexagonum*, *C. serratum*, *C. tricarinatum*. *C. vittatum*,

C. clavatulatum, *C. echidnoides*, *C. angulosum*, *C. cristatum*, *C. calcitrapoides*, *C. denticulatum*, *C. umbrellatum*, *C. lamellosum*, *C. thiara*, *C. mutabile*, *C. semicoronatum*, *C. cinctum*, *C. plicatum*, *C. conoideum*, *C. Confluens*, *C. clavus*, *C. baccillum*. *C. scabrum*, *C. asperellum*, *C. turritellatum*, *C. mitra*, *C. pleurotomoides*, *C. involutum*, *C. tuberculosum*, *C. bicarinatum*, *C. trochleare*, *C. trochiforme*, *C. muricoides*, *C. purpura*, *C. conoidale*, *C. subulatum*, *C. lapidorum*, *C. petricolum*, *C. spiratum*, *C. columnare*, *C. substriatum*, *C. quadrisulcatum*, *C. umbilicatum*, *C. perforatum*, *C. clavosum*, *C. cancellatum*, *C. semigranosum*, *C. acicula*, *C. terebrale*, *C. inversum*, *C. melanoide*, *C. larva*, *C. gracile*, *C. incertum*, *C. emarginatum*, *C. rugosum*, *C. giganteum*, *C. nudum*, *C. unisulcatum*, and *C. turritellatum*.

Observing on the numerous species of this fossil, M. Lamarck says, we may with reason be exceedingly astonished at seeing so many species of one genus, almost all of which are unknown to the naturalist, and by far the greater part found in one spot; and adds, that we are hence authorized, in some degree, in believing that the remains of fossil shells, which are found inland, are there more abundant than the shell-fish which now inhabit our seas. *Annales du Museum, &c.* Tome III. p. 441.

The specimen of *C. spiratum*, Plate VI. Fig. 6, is particularly interesting, from its substance being completely calcedonic. At first view it might be supposed to be merely a cast; but this is not the case; the whole substance of the shell being now a very transparent calcedony, displaying distinctly the minutest characters of the species. A row of large tubercles, placed over the middle of each winding, renders the spire knobbed, and almost spinous. Striæ are seen crossing each other, over the whole surface; the transverse striæ being larger than the others, and rather tuberculated, having the appearance of minute chains. Three of these, distinct and separate, are plainly visible on the last turn. A notch in the lip is also seen nearly contiguous to the last turn but one. This notch appears, however, to be accidental. This curious fossil I extricated from a calcedonic mass from France.

Among the Veronese fossils which I possess, is one which, though somewhat mutilated about the aperture, bears not only sufficient proofs of its belonging to this genus, but strong marks of its species, *C. interruptum.* It is of a remarkable size, being nearly four inches long.

In the stratum of fossil shells running through Plumsted and Woolwich, and appearing at Bromley, in Kent, shells of this genus are frequently found, but in so brittle and so injured a state, as not often to allow of their species being made out. I have, however, I think, discovered *C. turritellatum, C. denticulatum, C. serratum, C. clavatulatum, C. mutabile*, and *C. cinctum*.

In the whetstone of Blackdown Hills, Devonshire, a turreted shell exists in considerable numbers; but it is very difficult to extricate them from the matrix, with their mouth perfect. I think, however, that I am right in considering these as belonging to *C. turritellatum.* They are completely silicious; and many of them, with their included matrix, are transparent.

The most extraordinary shell of this genus is, *C. giganteum.* It is turreted, extremely long, and transversely striated: the turns, in their upper part, are tubercular, and the columella has one fold. These enormous shells are generally a foot in length. One of the specimens which I possess, and which has lost at least an inch or two of its length, still measures fourteen inches. They are found at Grignon, and are not very rare: they are however, in general, very much injured, very seldom indeed having the lip and sides of the opening perfect. Their form is that of a winding turriculated pyramid, with in general twenty turns, beset on their upper part with a row of nodular tubercles, and having the general surface lightly and transversely striated. The opening is oblong and oblique, and terminates in the lower part in a canal, the extremity of which is moderately recurved; and the superior part, instead of forming a canal, is laterally extended, in the manner of an ear-like process. There is only one fold on the columella. This is, undoubtedly, the largest unilocular univalve shell that is known.

Mr. J. C. Delametherie, *Journal de Physique, &c.* Tome LXV. Nov. 1807, says, "I have a gigantic fossil cerite, *cerites gigas*, Lam. which Mr. Maclure, of the Philosophical Society of Philadelphia, found at Grignon, in a mineralogical tour which we made there in the month of July. It is the largest which is known. Its circumference, near the mouth, is from twenty-two to twenty-three inches, or about seven inches and a half in diameter. The thickness of the lip is about seven lines. Its complete length should be about thirty inches; but it is broken, and the piece which I have is but about ten or twelve inches long.

In addition to this statement of the learned author of *La Theorie de la Terre*, I have the pleasure to state, that I am in possession of a nearly corresponding specimen, a cast, which I purchased out of the Leverian collection, and which in all probability was obtained from Grignon. It is a lime-stone cast, in which six turns, with the mouth, is so well preserved, as decidedly to determine it to have derived its form from a shell of this genus. This shell must have exceeded in size that of M. Delametherie; since, independent of the thickness of the shell, its greatest circumference, near to the mouth, is nearly twenty-four inches; its diameter being, of course, about eight inches. This specimen is about sixteen inches in length; and its weight, there being no externally adhering matrix, is full twenty-one pounds and a half. M. Delametherie concludes, from his fragment, which is from ten to twelve inches in length, that the shell must have been thirty inches in length; but I think, from the proportions of my fragment, which, being nearly six inches longer than that of M. Delametherie, gives better grounds of calculation, that he may have over calculated the original length of the shell; since I cannot believe that my specimen, if perfect, although larger than his, would have attained more than twenty-eight inches.

Different species of this genus are found, in delicately beautiful calcareous masses, in the neighbourhood of Courtagnon. But among

the most interesting and extraordinary masses, containing shells of this genus, are the calcedonic masses, which are also found in some part of France.

The latter specimens are rendered particularly interesting, from the circumstance of the shells themselves appearing to be converted into a calcedonic substance. The matrix is opaque, and of a pale greyish colour; whilst the shells themselves are nearly transparent, and of a yellowish brown colour. A close examination seems to show, that the matrix was composed chiefly of a gritty, calcareous, or silicious mass, which has had fluid silex diffused through it, and most probably at the time when the change in the substance of the shells was effected. But to ascertain the real nature of the change, and to form a rational opinion as to the mode in which the carbonate of lime has been removed, or so changed as not to prevent the transparency of the fossil shells, I confess myself entirely incompetent.

XXXVI. *Trochus.* A conical spiral univalve, with a transversely depressed and rather quadrangular opening; with an oblique axis.

Lamarck has separated from the genus *Trochus*, of Linnæus, those shells which possess such peculiar characters as warrant their being arranged under two new genera, which we shall presently notice; *Solarium* and *Monodonta.*

At Grignon is found the remarkable carrier trochus, *T. agglutinans*, Lam. *T. conchyliophorus,* Lin. distinguished by its curious property of attaching and agglutinating to its surface small shells, pebbles, fragments of coral, &c. M. Lamarck gives the figure of one of these fossil shells, loaded with small bivalves; but none of the specimens which I possess are loaded: they, however, show sufficient marks of the attachment of numerous foreign bodies, and even retain the impressions of the very minute markings of small shells which had been affixed to them. A specimen of this species of shell which I possess, from Verona, is remarkable for its size; the diameter of the base, and of the side of the cone, each measuring above three inches.

T. monilifer, Lam. *T. nodulosus.* Brand. is an elegant shell, and in the French specimens has its markings exceedingly well preserved. *T. sulcatus*, Lam. extremely like to *T. granulatus*, of Born. Tab. XII. Fig. 9 and 10, was obtained by Lamarck from the neighbourhood of Pontchartrain, as well as from Grignon. I found one specimen of this shell among the Harwich fossils, but which I have since broken. *T. alligatus*, Lam. is distinguishable by six transverse ribs, some of which are cord-like, and others crenulated. I have likewise found small specimens of this shell in the Essex cliff.

Among the Veronese fossils is one which has a singularity of appearance, proceeding from a slight convexity in the sides of the cone. It is formed of six whirls, on which are three rows of closely set, but distinct beads; the base, which is circularly striated, possesses a considerable degree of concavity. From this circumstance it has been named *T. concavus;* but as this property is very common, I should prefer the name *T. convexus*, from the convexity of its sides.

Lamarck describes eight fossil species of this genus: *T. crenularis*, *T. monilifer*, *T. sulcatus*, *T. alligatus*, *T. ornatus*, *T. subcarinatus*, *T. bicarinatus*, *T. agglutinans.*

Very large casts of this genus are found in different parts of Oxfordshire, Gloucestershire, and Somersetshire; those in the neighbourhood of Bath being sometimes beautifully adorned with brilliant pyrites.

XXXVII. *Solarium.* A depressed conical, nearly discoidal, umbilicated univalve shell; with the umbilicus crenulated or denticulated at the margins of the windings. The opening approaching to quadrangular.

The shells placed by Lamarck in this genus, were included by Linnæus in the genus *Trochus;* and are sometimes difficultly distinguished from the shells of this genus, as well as from those of the genus *Planorbis.* They are however, in general, plainly characterized by their large umbilicus, crenulated or denticulated at its sides. One species of this genus is found among the Hampshire fossils. *Sola-*

rium canaliculatum, Lam. *Turbo*, Brand. *Foss. Hant.* Plate X. Fig. 7 and 8. This shell is distinguished by its being marked, both on the upper and under surface, with transverse granulated beadings. The umbilicus large, funnel-shaped; crenulated and canaliculated on the internal edge of each turn.

Lamarck describes nine species: *S. patulum*, *S. sulcatum*, *S. canaliculatum*, *S. plicatum*, *S. spiratum*, *S. ammonites*, *S. patellatum*, *S. disjunctum*, *S. bipons*.

XXXVIII. *Turbo*. A conoidal or slightly turreted shell, the opening complete, rounded, and not toothed; the margins always disjoined in the upper part; the columella smoothed at the base.

It is from this latter circumstance, the end of the columella smoothly blending with the right margin, and not forming a projecting tooth, that this genus is separated from *Monodonta*. Some of the shells of this genus very much resemble those of the genus *Helix;* but are to be distinguished from them by the roundness of their opening not being broken, by the projection into it of the last turn but one of the spire, which is the case in the *helices*. Young specimens of *cyclostomæ* may also be confounded with *turbines;* since, in their young state, they also have their margins disjoined, like the *turbines;* but, in their full-grown state, they become circularly united, which the *turbines* never do.

Lamarck gives four species of this genus: *T. squamulosus*, *T. radiosus*, *T. helicinoides*, and *T. denticulatus*. The latter he has found fossil at Grignon.

XXXIX. *Monodonta*. An oval or conoidal shell, the opening entire, roundish, with the two margins disunited: the truncated base of the columella forming a tooth, projecting into the opening.

This genus, of Lamarck, may be exemplified in *Trochus labio*, Linn. This shell is not among the Paris fossils; nor do I know of its existence among the fossil shells of this island: species of it are, however, to be found in the cabinets of collectors.

XL. *Delphinula.* A subdiscoidal, or short conical, solid, pearly, umbilicated univalve, with rather rough turns. The opening round; the margin circular and uninterrupted.

This genus is formed of shells, which were included by Linnæus in his genus *Turbo;* a genus which he formed merely on the character of the complete roundish opening of the shell. Lamarck, for the sake of greater accuracy of distinction, has separated from this genus those shells, in which the two edges of the opening are circularly united; and has left to the genus *Turbo* only those sea shells, which, possessing a rounded opening, have the two edges of the opening constantly disjoined near the columella. With the shells which have been thus withdrawn from the genus *Turbo,* he thought it necessary to form the genera *turritella*, *scalaria*, *pupa*, and *cyclostoma.* But even thus, some confusion would exist; since *cyclostoma* would contain both sea shells and land shells. To avoid this, the present genus is formed for the reception of the sea *cyclostoma,* whilst the land *cyclostoma* are all reserved for the genus so named. In the delphinulæ the edge of the opening is not reflected outwardly, nor is the point of the columella visible.

Turbo testa umbilicata convexa, aufractibus, teretibus striatis: striis crenulatis inæqualibus. Apertura omnino orbicularis. Foss. Hant. Tab. I. Fig. 7 and 8, may be taken, as exemplifying this genus. I am not acquainted with another British fossil of this genus; whilst, of those found in the environs of Paris, Lamarck enumerates eight species: *D. calcar, D. lima, D. conica, D. turbinoides, D. marginata, D. striata, D. sulcata, D. canalifera.*

With respect to the fossil shells to which I now call your attention, I must acknowledge my inability to determine precisely in what genus they should be placed. Their characters, however, approaching the nearest to those of this genus, I have placed them here, until more illustrative specimens have pointed out for them a more appropriate situation.

Plate VI. Fig. 1, is the upper side, and Fig. 3, the under side, of a limestone fossil, not very uncommon, I believe, in the neighbourhood of Bath. It is somewhat of a discoidal, or rather of a plano-concave form, and is in general from two to three inches in breadth. Its spiral convolutions, which are from four to five in number, are strongly carinated, in the direction of the turns, on nearly the middle of the upper side, and become slightly grooved towards the next inner turn. On the under side, they are of a roundish form, and marked with slight but frequent oblique rugæ; the turns being so disposed as to form, in the under part, a tolerably smooth funnel-formed cavity. In one species, distinct nodular projections exist on the lower side of the spiral turns.

None of the specimens which I possess are in sufficiently good preservation to allow me to speak decidedly respecting the aperture of this fossil. I am only enabled to observe, that none of the preceding whirls project into the hollow of the next; as, from my specimens being fractured in several places, I am able to perceive that the ridge on the upper part of the shell is a solid external projection, which no ways affects the circular cavity of the shell. Hence there is reason to conclude, that the mouth is round, and not diminished by the projection into it of the preceding whirl, as takes place in the *planorbites.*

This fossil was first described by Mr. Walcot in these words: "Depressed, volutions three, a sharp ridge runs in the centre of the upper surface of the volutions. *Lime-stone.*" *Descriptions and Figures of Petrifactions, &c.* Fig. L. and LVI.

As far as I am able to judge, from such parts as have not suffered injury, or are not concealed by the adhering matrix, the fossil represented Plate VI. Fig. 7 and 8, is another species of the same genus, in which the preceding fossil should be placed. It is discoidal; but the central projecting termination of the spire is elevated in a peculiar manner, so as at first sight to give it the appearance of being detached from the next turn. On closer examination this is, however, found not to be the case; since a connection is formed by an

expansion from the next turn, the rugæ of which are continued very closely and regularly up this central projection, to where it has been broken off: this is formed by two flattish turns, which, on their upper surface, are marked by slight longitudinal rugæ, which terminate in two ridges, disposed on the inner and on the outside of each turn. These turns, on the lower side, are roundish, and are very thickly set with sharp and irregular rugæ, and seem to form a concavity nearly corresponding to the elevation on the other side; but in this concavity an irregular shelly body exists, which appears not to be accidental, but a part of the original shell. Fig. 7 represents the under part, with this irregularly formed body, and Fig. 8 represents the upper surface, with its projecting central termination. An endeavour is made to give a representation of the aperture of this shell, of which description could hardly have given a satisfactory idea; indeed, it is so much obscured by the surrounding matrix, as to prevent a correct figure of it being obtained. The matrix of this fossil is a yellowish lime-stone, with which the hollow of the shell is completely filled.

The fossil, Pl. V. Fig. 18, which appears to be of the same genus with the two preceding, is so figured, as to show a portion both of its upper and under part. On the former, the turns of the spire are seen covered with closely-set transverse ribs, the spire terminating in a roundish projection. The turns of the spire are ribbed in the same way on the under side; and here a projecting shelly body is seen in the concave part, answering, in its situation, to the irregular formed body in the preceding fossil; and to the projecting superior termination of the spire in the same fossil, in having the markings of the spiral turns continued upon it.

It would be premature to attempt to establish a genus for the reception of these fossils, until more particulars are ascertained respecting the original size and real nature of the projecting bodies which appear to belong to both the upper and under surface of these fossils. Should the appearance of these be found to be constant, that alone would, of course, form a generic distinction.

I am not acquainted with the *habitats* of either of these two last mentioned fossils; but imagine, from the appearance of the matrix, that they are from the neighbourhood of Dudley, in Worcestershire.

XLI. *Cyclostoma.* A discoidal or convexo-conical, nearly transparent univalve, with cylindraceous turns. The opening round, with a circularly continued margin, suddenly and widely thrown back.

The *cyclostomæ*, in their adult state, have their margins always reflected, which is not the case with the *delphinulæ;* but they are more certainly distinguished from each other by the thinness of the shell of the *cyclostomæ,* and by their never having any nacre, which is always possessed by the *delphinulæ. Cyclostoma spiruloides,* Lam. is a minute species of this genus, the form of which may easily be comprehended without a figure; since it is formed by three turns, spirally disposed, in the same manner as in the *planorbes:* the last turn being so detached from the rest, as to give it the appearance of a young *nautilus spirula.*

It must be observed, that there are some shells, not yet classed, whose openings are round, and whose margins are united like the *cyclostomæ;* but in which, unlike the *cyclostomæ,* the margins are not dilated nor reflected, and which are of an elongated or turriculated form.

Lamarck describes six fossil species: *C. cornu pastoris, C. spiruloides, C. planorbula, C. macrostoma, C. mumia, C. turritellata.*

XLII. *Scalaria.* A turreted univalve, with acute longitudinal raised ribs. The opening nearly circular; the margins uninterrupted, bordered, and reflected.

The raised ribs sufficiently distinguish the shells of this genus from those of *delphinula* and *cyclostoma.*

I am not in possession of any fossil of this or of the two preceding genera; nor do I know of any having been found among our English fossils. Lamarck has discovered five species of this genus among the fossils of Grignon and Pernes: *S. crispa, S. decussata, S. denudada, S. monocycla,* and *S plicata.*

XLIII. *Turritella.* A turreted univalve shell; the opening entire, and rounded; with the margins disjoined in the upper part; and a groove in the right lip.

As it appeared to be necessary to separate the genus *Vis* from *Buccinum,* in consequence of the turriculated shape of the former shells, so it is necessary to separate *Turritella* from *Turbo, Cyclostoma, Pupa,* and *Scalaria;* the shells of the genus *Turritella* having all a notch at the right side of their opening, which is not the case with any shell of the other four genera.

Turritellites perforatus, Lam. Plate V. Fig. 12, is a very curious species of this genus, the columella being perforated through the whole axis of the shell. This peculiarity exists in the shell here figured; but it does not exactly agree with that which is described by Lamarck; since its turns are smooth, while those of the shell which he describes have three or four transverse striæ. The difference may be only that of a variety; or the surface, in my specimen, may be somewhat altered by decomposition or friction.

In a large fossil shell of this genus, now before me, a very curious circumstance is observable. The shell has been completely fractured across, and afterwards united by that astonishing power of reparation which is perhaps possessed by all shell-fish.

Some species of this genus are found in Hampshire, particularly *T. terebellata,* Lam. *Turbo terebra,* Brand. *T. imbricataria,* Lam. and *Turbo editus,* Brand. This latter shell has been found, very fine, in the neighbourhood of Selsea, with several other of the same shells as are found in Hordwell Cliff, by Mr. J. Holloway, of Portsmouth. This gentleman, to whom I am obliged for this information, and for several of these specimens, relates that he also found this shell, with others which I shall have occasion to notice, in a blue mud at the base of Stublington Cliff, between Stoke's Bay and Southampton.

Among the pyritical shells of the Isle of Portland are frequently found shells of this genus. Impressions of shells of this genus, as well

as of the genus *Certithium,* are frequently seen in the Portland free-stone. Shells of this genus are also frequent among the Veronese and Vincentine fossils.

Lamarck enumerates ten species among the fossils of Grignon, Chaumont, &c.: *T. imbricataria, T. sulcata, T. subcarinata, T. fasciata, T. multisulcata, T. terebellata, T. perforata, T. unisulcata, T. uniangularis, T. melanoides.*

XLIV. *Pupa.* A somewhat cylindrical univalve; the last turn of the spire, which is somewhat produced, not being larger than the preceding: the aperture irregularly roundish or oval; the margin continued circularly.

Turbo uva, Linn. Born. Vign. Fig. E. is the type of this genus, which does not appear to be known fossil.

XLV. *Janthina.* A subglobose diaphanous univalve: the opening triangular, with an angular sinus on the right edge.

Helix janthina, Linn. List. Tab. 572, Fig. 24, is of this genus; no shell of which has, I believe, been found fossil.

XLVI. *Bulla.* An ovate, gibbous, and somewhat cylindrical univalve: the spire not standing out, but concealed within: the opening the length of the shell: the lip acute.

Bulla aperta, Linn. and *Bulla lignaria,* Linn. are contained within the membranous part of the molluscæ by which they are produced, so that these molluscæ appear naked, or without any external shell; but the lively colours, and the repeated convolutions of other species, as *Bulla ampulla,* Linn. &c. show that these have not been contained within the soft part of the animal. Lamarck, apprized of this circumstance, has separated the former animals from the genus *Bulla,* and has formed with them a genus of the naked molluscæ, and named it *Bullæa,* leaving in the genus *Bulla* those species, the shells of which, possessing the above-recited generic characters, form the external covering to the animal.

I do not know of any English fossil shells of this genus. Respect-

ing *Bulla sopita*, Brand. *Fossil. Hanton.* Fig. 29, *a.* and *Bulla volutata*, Brand. *Fossil. Hanton.* Fig. 75, another, and apparently a more appropriate place has been allotted them, in a former part of this volume (Letter VI. p. 54;) and with respect to *Bulla simulata*, Brand. *Fossil. Hanton.* Fig. 61, it certainly can have no claim to be considered as a *Bulla*, the spire being acutely pointed, the cauda produced, and the columella plicated.

The bullites of the environs of Paris appear to be divisible into four species: *B. ovulata*, *B. striatella*, *B. cylindrica*, *B. coronata.*

XLVII. *Bulimus.* An ovate or oblong subturreted shell: the opening entire, oblong, and longitudinal, having, in adults, an external reflected margin: the columella smooth, the base entire, not spread out.

The oblong and longitudinal opening of the shell is, according to Bruguiere, the chief characteristic of this genus: Lamarck, also, adopts this distinguishing mark; and, by the assistance of other essential characters, has formed from the genus *Bulima*, of Bruguiere, not only this genus, but those of *Agathina*, *Lymnea*, *Melania*, *Auricula*, and *Pupa.*

The shells of this genus are inhabited by an animal much resembling that which belongs to the genus *Helix.* The shells of the two genera, however, differ, in the opening of the *Helix* being wider than it is long, whilst that of *Bulimus* is always longer than it is wide. The snail, too, has a round or orbicular shell, and that of the *Bulimus* is oblong, conical, or turriculated. The margins, in *Bulimus*, are separated in the upper part; but in *Helix*, the last turn but one of the spire projects into, and thereby contracts, the opening. The shells of *Bulimus* are distinguished from those of *Melania*, by their having no widening at the base of their opening; and from those of *Lymnea* by their not having a distinct and very oblique fold, which is seen in the shells of the last-mentioned genus. *Bulimus* is a land shell; but *Lymnea* and *Melanea* are fresh-water shells.

I do not know of any British fossil species; But lamarck describes ten species decidedly of this genus: *B. albidus*, *B. citherella*, *B. terebellatus*, *B. acicularis*, *B. nitidus*, *B. sextonus*, *B. conulus*, *B. clavulus*, *B. striatulus*, and *B. nanus.* He also speaks of five more species, respecting the classification of which he is less certain.

XLVIII. *Achatina.* An oval or oblong univalve: the opening entire, and longer than wide; the columella smooth, and truncated at its base.

Bulla achatina, Linn. List. Tab. 579, Fig. 34, is of this genus; no species of which is known fossil.

XLIX. *Phasianella.* A solid ovate or conical univalve: the opening longitudinal, ovate, and entire; with a sharp plain lip: the columella smooth, with an attenuated base.

The opening of the shells of this genus is almost the same as that of the shells of the preceding; but the shells of this genus are sea-shells, and are not transparent, but thick. Lamarck describes two species of this genus, which are found among the fossil shells of Grignon: *P. turbinoides*, and *P. semistriata.*

L. *Lymnæa.* An ovato-conical, or turreted, univalve; the aperture entire and oblong; the right lip joined to the left, in the lower part rising on the columella, and showing internally an oblique fold.

The character by which these shells may be distinguished from the *Bulimi*, is, the very oblique fold on the columella. *Helix stagnalis*, Lin. List. Tab. 123, Fig. 21, is of this genus. The fossil remains of these shells are very rare. Lamarck has only discovered those of one species in the neighbourhood of Paris, which he names *Lymnæa palustris.*

LI. *Pyramidella.* A turriculated univalve: the opening entire and semioval: the columella projecting, with three transverse folds, and perforated at its end.

Trochus dolobratus, Lin. List. Tab. 844, Fig. 72, is of this genus; no species of which have been described fossil.

LII. *Melania.* A turreted univalve: the aperture entire, ovate,

or oblong, and spread out at the base of the columella, which is smooth.

The shells of this somewhat resemble those of the preceding genus; but are easily distinguished from them by the widening at their base, and by the columella being smooth.

I do not know of any English fossil of this genus; but they appear to be frequent in the environs of France; since Lamarck enumerates and describes twelve species: *M. costellata*, *M. lactea*, *M. marginata*, *M. hordacea*, *M. canicularis*, *M. corrugata*, *M. semiplacata*, *M. nitida*, *M. semistriata*, *M. cochlearella*, *M. fragilis*, *M. dubia*.

M. marginata, represented Plate V. Fig. 9, judging from the specimens in my possession, exists in a very unimpaired state.

LIII. *Auricula*. An ovate or oblong pyramidal univalve, with the spire extruded: the opening entire, oblong, and narrowed upwards; the columella plicated, with different plicæ in the opposite lip.

Those volutes of Linnæus, which are not notched at their base, Bruguiere, without considering their plicæ, placed under the genus *Bulimus*. Lamarck has, with great propriety, placed those shells whose openings are entire, but whose columellæ are plicated, under this genus, *Auricula*.

One of the most interesting shells of this genus, is *Auricula ringens*, Lam. acutely ovate, rather turgid, transversely ribbed, with minute longitudinal striæ, the edges of the opening thick and bordered, the right lip dentated, and the columella with three plicæ. This shell is found at Grignon, and in the neighbourhood of Bourdeaux. The specimen which is represented Plate V. Fig. 4, and which appears to be *A. ringens*, is nearly transparent. It is one of those extraordinary silicious fossils which are yielded by the Blackdown whetstone-pits, and for a supply of which I am under great obligations to R. H. Clarke, Esq. of Bridwell, and the Rev. J. R. Cleeve, of Kentisbeare, who have kindly assisted me with the interesting fossils of their respective neighbourhoods.

LIV. *Volvaria.* A cylindrical convoluted univalve: the spire not extruded: the opening narrow, the length of the shell: the columella plicated at its base.

This shell, for Lamarck knows but of one species, *V. bulloides,* which is fossil, approaches very near to *Bulla cylindrica,* or *Bulla solida;* but differs from the genus *Bulla,* in having its columella plicated.

LV. *Ampullaria.* A ventricose subglobose univalve, with an umbilicated base: the opening oblong and entire, with no thickening on the left lip.

The *Ampullaria* is a river shell of the warm climates. Its spire, which always projects a little, distinguishes this genus from *Planorbis;* and there being no thickening on the left lip, distinguishes it from *Natica.*

Ampullaria patula, Lam. is *Helix mutabilis,* Brand, Foss. 57. Tab. IV. In Brander's figure the back is only seen; and the patulous opening, the specific characteristic, is not shown. *A. sigaretina,* Lam. differs from the preceding, chiefly in having no umbilicus.

From the greatest part of these shells, answering to the preceding description, being marine shells, and somewhat approaching in character to the genus *Natica,* Lamarck is disposed to think that they belong to a genus not yet established. Twelve species appear to exist among the fossils of the environs of Paris: *A. pygmæa, A. excavata, A. conica, A. acuta, A. acuminata, A. spirata, A. depressa, A. canaliculata, A. patula, A. sigaretina, A. crassatina, A. hybrida.*

A. spirata, I find among my Veronese fossils; and *A. conica,* and a shell much resembling *A. rugosa,* I have found among the shells of the Essex cliff.

LVI. *Planorbis.* A discoidal univalve. The spire depressed, hardly at all prominent, the turns conspicuous on both sides. The opening entire and oblong; the margin never reflected.

The shells of this genus are fresh-water shells: their inferior face is known, by its being more sunk in than the upper; and from the gradual diminution of the turns towards the centre, forming a funnel-formed cavity.

From the original delicacy of structure of these shells, from the circumstances under which they have become buried, and from the slight degree of mineralization which they have undergone, it is difficult to obtain their fossil remains in tolerable preservation.

Lamarck has met with three species among the fossils of the environs of Paris: *P. nitidula*, *P. subangulata*, *P. bicarinata*.

LVII. *Helix*. A globular or orbicular shell, with a convex or conoidal spire: the opening entire, wider than long, and diminished in its upper part by the projection of the last turn but one of the spire.

Shells of this genus, as well as other land and fresh-water shells, are rarely found in a state of petrifaction. The circumstances of conservation in which they are found are, generally, such as are explicable on the supposition of their having become involved in the gradually accreting tufaceous matter, which is deposited by certain streams and rivers; or in the stalactitic concretions forming in the cavities of limestone rocks, of comparatively modern formation.

Instances of the former kind are to be met with in various parts of this island, as well as in numerous other parts of the world; but the most remarkable instance of the latter kind is in the rock of Gibraltar, in which shells of this description are sometimes found.

LVIII. *Helicina*. A subglobose univalve, with no umbilicus: the opening entire, and semi-ovate; the columella callous, depressed at the lower part, and flattened.

The analogous recent shell on which, I believe, Lamarck founds this genus is, *trochilus, labro protenso, fasciatus*, List. *Hist. Conchyl.* Plate LXI. Fig. 59. It differs from *Helices* in its callous columella, and in a little angle, which the base of the right edge forms, before re-uniting itself with the base of the columella. This ingenious naturalist finds only one fossil shell which he can place, even with hesitation, under this genus. This incertitude, he candidly acknowledges, and even implies it, in the name which he has affixed to this species, *Helicina dubia*. I know of no fossil shell of this genus.

LIX. *Nerita.* A semi-globose univalve, depressed beneath, and having no umbilicus: the opening entire and semicircular; columella nearly transverse and flat, with an acute, and generally dentated, edge.

The shells of this genus differ from those of *Natica,* in never being at all umbilicated.

Nerita conoidea, Lam. *Nerita perversa,* Gmelin, is, as well from its form, as from the extraordinary magnitude which it sometimes possesses, a very remarkable fossil. It is conical, with a very broad base; the apex of the spire is inclined, and the columella is furnished with eight teeth.

Chemnitz, and other naturalists, have thought that this was a reversed shell; but Lamarck has shown that its turns are in the ordinary direction, from the left to the right. It acquires, however, a peculiar appearance, from the top of the spire being inclined to one side, as if the axis of the spire had been broken or bent in its upper part; hence the shell is irregularly conical. The upper part is smooth, or only slightly striated, in a transverse direction, agreeable to the successive addition of new matter to the shell. The opening, which is nearly semicircular, possesses about one-third of the base. The size of some of these fossils is very considerable. Lamarck observes that the width of the largest specimen is seven centimetres, (about two inches *Fr.* and seven lines.) One of the specimens which I possess is hardly more than an inch across its widest part; whilst another, which I purchased from the collection of M. de Calonne, measures in the same direction full three inches and three quarters, and exceeds two inches in height. These gigantic proportions widely distinguish it from any recent shell of this genus. These fossils are from Retheuil and Courtagnon. I am not acquainted with the discovery of any shells of this genus among our English fossils.

Plate VI. Fig. 4, is a curious fossil, being a calcedonic cast of the hollow of a nerite of this species, displayed by the removal of the top of the shell.

The under side of this fossil, showing the mouth and dentated lip of *N. conoidea*, is represented Plate VI. Fig. 6.

This, with another specimen, in which the cast is entirely detached from the shell, was purchased from the Callonnean collection, and is from Courtagnon.

I have the *N. conoidea*, in very good preservation, from the Valley of Ronca.

Lamarck particularizes three species of this genus as being found among the French fossils: *N. conoidea, N. tricarinata, N. mammaria.*

LX. *Natica.* A nearly globose umbilicated univalve: the opening entire and semicircular; the columella transverse, without teeth, and callous externally; the callosity narrowing, or even covering, the umbilicus.

These shells bear considerable resemblance to *Neritæ*, in the form of their opening; but they obviously differ from the shells of that genus, in always being umbilicated, and never having their columella dentated.

Natica cepacea, Lam. is a species remarkable for its flattened roundish form, and still more for the large thick callous mass, with which the umbilicus is covered, in the adult specimens. *N. canrena* is a frequent fossil in the Essex bank of fossil shells. Another species of this genus is also frequently found in this bank, which is figured by Dale, *History and Antiquities of Harwich, &c.* Plate X. Fig. 16, and by him referred to *Cochlea sublivida ore fusco, ad basin cujusque orbis velut funiculus depingitur*, Lister, *Hist. Conchyl.* Plate 508, Fig. 19. The shell there depicted is evidently *N. canrena;* but the Harwich fossil shell has a simple umbilicus, and not an umbilicus intersected by a callous process, as is the case in *N. canrena.* This fossil seems more nearly to resemble *N. glaucina*, as represented by Lister, Plate 562, Fig. 9, of the same work.

Among the most rare of the Blackdown fossils, is a *Natica*, approaching in its character to *N. canrena*, Linn. and *N. epiglottina*,

Lam. except that the callosity lays in the contrary direction to what it does in those species. The only one I know of was extricated from a mass of the whetstone, which still fills its matrix, Plate VI. Fig. 2. It is so thoroughly silicious, as to be transparent, where the matrix is not interposed.

Lamarck describes three species of this genus as French fossils: *N. labellata*, *N. epiglottina*, *N. cepacea*.

LXI. *Testacella.* An obliquely conical formed univalve, with the summit a little turned spirally; the opening oval, with the right edge turned inwards.

LXII. *Stomatia.* An oval auriform univalve, with a prominent spire: the opening ample, and longer than wide; the disk imperforate.

LXIII. *Carinaria.* A very thin univalve, in the form of a cone flattened on its sides, the apex terminating in a very small involuted spire, and the back having a dentated keel: the opening entire, oval-oblong, contracted towards the angle of the keel.

No remains of any shells of the three preceding genera have, I believe, been found fossil; nor are the inhabitants of the two latter shells known.

LXIV. *Haliotis.* A flattish, ear-formed shell, with a depressed spire, and a row of round holes along the right edge. The opening very large, and much longer than wide.

M. Bosc observes that these shells are often found fossil in France and Italy. On this point I am obliged to observe, that, from the information which I have gained, from the sight of different collections, and from the examination of different authors, I conceive the contrary of this to be the fact. Indeed, of the seventeen species which M. Bosc enumerates, he mentions but one species, *Haliotis plicata*, as having been found fossil. I do not indeed, therefore, hesitate in saying, that the shells of this genus are among the rarest fossils.

The nearest approach to this genus is a shell which is sometimes found among the fossils of St. Peter's Mountain, and has been hitherto

considered as a *Haliotis*, but which certainly belongs to the following genus, which differs from *Haliotis*, in being without holes.

LXV. *Sigaretus.* A depressed oval, nearly auriform, shell, with a short spiral columella: the opening entire, very wide, spread out towards the summit of the right lip, and longer than wide.

The shell, for the reception of which Lamarck formed this genus, is the Venus's ear; *Sigaretus*, of Adanson; *Helix haliotidea*, of Linnæus; and *Bulla velutina*, of Muller. This is an exceedingly rare fossil. The only specimen which I have seen is one which I obtained at the sale of the Museum of Mr. Strange; and which, I afterwards discovered, by the purchase of some of Mr. Strange's manuscripts, had been thought of sufficient consequence to be the subject of a plate engraved by Antonio Gregori, from a drawing of Gaspero Massini. This is a Tuscan fossil.

A fossil shell of this genus, but apparently not of this species, is found in St. Peter's Mountain, Maestricht, and is figured by Faujas St. Fond, *Hist. Nat. de la Montagne de St. Pierre*, p. 166, Plate XXVIII. Fig. 3.

Plate VI. Fig. 9, is a magnified representation of a shell of this genus, which is shown of its natural size, Fig. 10. This microscopic fossil was found in the calcareous sand contained in the cavity of a gigantic cerithites.

LXVI. *Argonauta.* A very thin involuted boat-like univalve; the spire turning into the opening; with a double, tubercular keel.

I have no knowledge of any shells of this genus having been found in a mineralized state.

LETTER VIII.

NEARLY STRAIGHT OR IRREGULARLY TWISTED SHELLS, WITH SIMPLE OR DIVIDED CAVITIES.....PENICILLUS.....DENTALIUM.....VERMICULARIA.....SERPULA.....SILIQUARIA.

Having now arrived at those shells which are formed into nearly straight, or partly spiral and partly straight, or irregularly contorted tubes, some of which are inhabited by *vermes*, and not by *molluscæ*, I have concluded it to be better to introduce these shells together here, than to separate them according to the difference of their inhabitants. This seems to be particularly proper, since several of these shells, as will be seen, are known only as fossils, and consequently we can form no determined judgment respecting the animals which formed and inhabited them. Besides, as several of these shells are concamerated, their examination will very naturally precede that of the shells of the next division.

LXVII. *Penicillus.* A tubular shell, narrow, and rather spirally turned at its origin, dilating into a club-form at the other end, which terminates in a convex disk, beset with small tubular perforations.

This shell, which is *Serpula penis,* Linn. has not been seen fossil; nor is the nature of its inhabitant known.

LXVIII. *Dentalium.* A tubular, conical, slightly bowed univalve, open at both ends.

Mr. Brander found, among the Hampton fossils, two species; the one of which he considered as *D. elephantinum,* and the other *D. entalis.* A specimen before me, of the latter fossil, seems in no respect to differ from the recent shell. Another of my Hampton fossils seems to possess the characters of *D. dentalis.*

The fossils which I possess of this genus are chiefly Italian. Among these I perceive, 1. *D. fossile*, Linn. approaching, by its numerous small longitudinal decussated striæ, to *D. striatulum ;* but differing from that shell in not being angulated; and in the cone, which it forms, diminishing more slowly towards its apex. 2. *D. sexangulum*, Linn. In this shell, the minuter striæ, interposed between the large angular ones, vary in their number from one to three. Some of these fossils possess all the characters of this species, but have their longitudinal striæ interrupted by obliquely-disposed, transverse, or annular striæ, placed at various distances. These, perhaps, should be considered as *D. annulatum.*

In the collection of Mr. Strange were some silicious casts, formed in the cavities of *dentalites.* These, being partly transparent, and partly of the whiteness and opacity of china, have a very beautiful appearance. I am totally uninformed, as to the place in which they were found, but suspect them to have been formed in the fossils above described, from Italy.

This shell is filled by one of the *Vermes*, possessing exterior organs.

LXIX. *Vermicularia.* A tubular shell, turned spirally at its beginning, but continued more or less contorted: the sides entire, through its whole length, and the opening simple and round. The inhabitant a cephalous mollusca.

Fossil specimens of shells of this genus appear to be by no means rare: silicious specimens are found in the green sandy stratum in Wiltshire. I have also specimens, from the collection of Mr. Strange, which were obtained by that gentleman from the hills of Tuscany. To one very fine fossil, which Mr. Strange considered worthy of being made the subject of an engraving of Gregori, after a drawing of Bonati, a piece of lace coral is attached, with a tubular shell, having the appearance of being formed by a series of funnel-formed bodies, the narrow parts of the superior being inserted in the wider parts of the inferior.

These fossils were at one time supposed to be the fossil remains of earthworms : a supposition not now requiring to be further noticed. I do not know a more appropriate place to dispose of the fossils represented Plate VI. Fig. 12 and 13, than under this genus. These vermiculites are found in the fissile stone of Pappenheim and Gunsterhausen ; and have, I believe, no recent prototype. In some, as in Fig. 12, the covering itself of the animal is left, intertwined in a remarkably tortuous manner. In others, as in Fig. 13, the impression only is left. Bodies of a similar kind are sometimes formed on the Veronese fossils. Similar bodies are sometimes found in the Devonshire Whetstone ; but less contorted, and laid more lengthwise. Plate VII. Fig. 2.

LXX. *Serpula.* A tubular adherent univalve, variously twisted or grouped, and sometimes divided by entire septa.

The definition which I have here adopted for this genus, and which is the Linnæan, with the addition of the form of the shell, will for the present comprise several shells, which, as has been already observed, may, when more fully known, be found worthy of forming distinct genera.

The common small tortuous and intertwined serpulæ, *S. glomerata*, are very frequently found amongst, and attached to, the fossils of this and of other countries. Several different varieties, or perhaps species, of these shells, result from the different external forms which they derive from the longitudinal or oblique rugæ which exist on their surfaces. Hence their external figure is trihedral, tetrahedral, and even hexahedral, according to the number of these rugæ. Plate VII. Fig. 1, represents a portion of a trihedral serpula, and the polished slab. Plate VII. Fig. 6, shows the appearance produced by a section, chiefly in the transverse direction of the shells of a species which is outwardly tetrahedral.

The serpulite, Plate VII. Fig. 5, seems to merit the term columnar. It is formed by a very small tube, disposed in contiguous turns, placed one on another, in nearly a horizontal direction, so as to constitute a small columniform body. The last and upper turn of the shell is pro-

duced in a perpendicular direction; the termination, containing the aperture, which is round, standing upwards. It is from the neighbourhood of Verona.

Plate VII. Fig. 4, is a small serpulite, the turns of which are spirally disposed on a horizontal plane, excepting the last; which, as in the preceding fossil, turns upwards.

The Kentish chalk fossil, Plate VII. Fig. 11, is a serpulite of a very curious form and character. It is formed of four spiral turns, the last of which is carried out a little way in a straight line, and then appears to have had its termination marginated. From its aperture another tubular body appears to have proceeded, the inferior part of which closely imitates, in its general appearance, the fringed, rugous, flat disc, serving as the foot of the snail. This also terminates with a marginated ring, forming a round aperture. The whole surface of the shell is marked by very fine transverse striæ; and at distances, increasing as the shell has grown, distinct annular projections are observable.

The extraordinary form of this shell, and particularly the appearance of that part, which, though it must always have been of a shelly hardness, bears so close a resemblance to the soft rugous part of the snail, led me very anxiously to seek for opportunities of examining its internal structure. I at last obtained two other specimens; and then found, on carefully breaking them, that at each of these annular projections, and at that part where the shell seems to commence anew, a close internal septum existed, which presented externally a concave surface, and which prohibited any communication of the chambers with each other, or with the animal, which doubtlessly lived only in the last formed chamber.

In this fossil we first observe a peculiarity of formation, which, as far as my knowledge extends, has not yet, although known to exist in several instances, obtained that attention which it seems to demand. In the nautilus, it is generally believed, that the division of the shell into chambers, into each of which a part of the animal is extended,

gives to the animal a power of raising or of lowering itself in the water, as its will directs. But in this shell the posterior chambers are shut up distinctly separate from each other, and of course have no communication with the last, or anterior chamber, in which the animal resides.

A slight attention only being paid to this fossil, it is probable, that the first idea excited respecting it may be, that its original construction was deficient in that astonishing adaptation of means to the ends proposed to be accomplished, which always exists in the works of nature. Cut off from all communication with the closed apartments which he had quitted, but to which he was still adherent, the animal could have had no power in influencing its librations in the water, and consequently seems to have been fastened to an useless and ungovernable incumbrance.

But here, as in every other apparent deficiency of design in the works of nature, only a further extension of our inquiries is necessary, to discover the wisdom of the Almighty Creator. The conformation of the inferior part of this shell shews it to have been adherent to the shell of some other animal: a circumstance, indeed, which at first thought seems to add little to our information; since the parasite, depending on the shell which supports it, for its loco-motion, seems to need no other peculiarity of conformation, than that which secures its firm adherence. But the shell to which it was attached might have been likely to be impeded in its own librations by an unlimited increase of the weight which was accumulated on it.

To prevent the occurrence of this circumstance, the structure of this appendage appears to be admirably well calculated; since the animal, with its shelly appendage, was, in all probability, thereby constantly kept at the same degree of specific gravity, through all the stages of the animal's growth. The formation of these several chambers doubtlessly resulted from the animal increasing the size of its receptacle, by lengthening and widening at its anterior part, quitting, as it advanced, the posterior part; and having finished its chamber for that period, shutting and sealing up so much of the hinder part of

the shell as it had then quitted. To enable it to do this, by forming a transverse septum of an appropriate form, it needed only to possess, at its posterior termination, an organization calculated for the secretion, deposition, and modelling, of shelly matter.

The absolute weight of the animal must necessarily have increased with its growth; but if with this increase of growth an additional chamber of air was produced, the animal and its appendage would preserve the same degree of specific gravity. It is evident, that whilst a due proportion was preserved between the solid part of the animal and these testaceous air-vessels, the animal to which they were attached would not be at all affected by their weight, let the number or size of those which were accumulated on it have been ever so considerable.

It seems to be a characterizing property of the animals belonging to some of the shells of this genus, to close or fill up all that posterior part of the shell which they do not inhabit: and in some of these we have seen, that by leaving these chambers empty, the shell and animal have probably preserved the same degree of buoyancy through their whole growth. But in another very curious species, the *Serpula heliciformis*, known only in a recent state, the whole dwelling of which appears to be not testaceous, but actually spathous, the posterior seeming snail part is gradually filled up, so as to become a solid mass of apparent spathose matter.

To account for this difference, it only seems to be required to consider that this shell does not attach itself to light bodies, whose buoyancy it would affect, but that it is always found imbedded in fixed masses of madrepore, and in general of *Madrepora meandrites*, Linn. where, from the body being fixed, in which it inhabits, no regulation of its weight is necessary.

The fossil, Pl. VII. F. 7, formed by almost horizontally disposed spiral turns, flattish, but rather rounded and slightly carinated on each side, the last turn being a little produced, and terminating in a round and distinctly marginated aperture, is, as well as the following, introduced in this

place with much doubt of the propriety of thus disposing of them. The fossil, Plate VII. Fig. 8, is from Shepey: some, still larger, are found at Bognor. Its spiral turns are placed partly one on the other, so as to form a nearly smooth convex upper and concave under surface: the turns themselves being nearly round, and beset with slight longitudinal ridges. The last turn of this fossil is very much produced, and terminates in a round distinctly bordered aperture.

The produced or extended turn of these and the preceding fossils, with the completely round and distinctly marginated mouth, have induced me to place them together: and, in consequence of the peculiar organization of the rugous part of the species, Fig. 11, I have no hesitation in considering it as an adherent shell, and of placing it among the serpulæ.

But with respect to the other two species, agreeing as they do with this fossil, as to their peculiar termination, I must acknowledge that I have no reason for supposing them to have been adherent shells. I have however ventured to assume this situation for them, until more correct observations shall allot them one more appropriate.

LXXI. *Siliquaria.* A tubular shell, spiral at its beginning, continued in an irregular form; being divided laterally, through its whole length, by a narrow slit, and formed into chambers by entire septa.

This is *Serpula anguina*, Linn. *Rumpf. Tab.* XLI. *Lit.* II. Baron Born has figured, *Born. Mus. Cæs. T.* 18, *Fig.* 16, two species, or, according to Linnæus, two varieties, of this shell, one of which is very strongly muricated. The animal itself is not known.

This shell is found frequently fossil at Grignon. M. Faujas observes, that these fossils have, on their outer surface, many rows of small protuberant striæ, which are more or less rough, and which run the lengthways of the shell. A narrow slit, more or less open, runs along the whole of the circumvolutions in some specimens; whilst in others its place is supplied by small narrow openings, separated from each other by intercepting points. This naturalist has discovered that these fossil

shells are chambered, by the interposition of thin hemispherical plates, without any syphon, at a little distance from each other. He has also ascertained, that these septæ, not only are not always at equal distances, but that sometimes they are fixed to the sides of the tubes, completely preventing any communication between these chambers; and that, at other times, on the contrary, they are not adherent to the sides, and may, of course, be easily removed.

The two specimens which I possess, of this fossil, are only two small fragments. In the one represented Plate VII. Fig. 3, is seen the nature of the change which the shell here undergoes. Through more than one half of its length the fissure is partially closed, evidently by the approximation and augmentation of the denticular processes, with which its sides are beset; and, through the remaining part of its length, the union of the sides of the fissure is complete. In the other specimen the fissure has been completely closed, a slight tubular excavation of the outer surface showing where the fissure had formerly existed. No septæ exist in either of these specimens.

In this shell, the fissure seems to fill up as the animal proceeds; the sides of each of the chambers being filled up, perhaps, before the portal is finally closed, by fixing the septa.

LETTER IX.

MULTILOCULAR SHELLS.........NAUTILUS.........FOSSIL SPECIES

ORTHOCERA.

We shall now proceed to the examination of the fossil remains of a family of shells, which, whether we consider the greatness of their numbers, the peculiarity of their structure, or the little agreement which exists between the greater part of them and known recent shells, cannot fail strongly to excite our interest and engage our attention.

These shells are *multilocular, being divided into chambers by transverse pierced septa :* a communication through the septa distinguishing these shells from those multilocular shells, which have been just examined.

Very little is known with respect to the animal which inhabits even the recent shells of this description. There is, however, sufficient reason for supposing that the animal resides in the last formed chamber of the shell, and is of the family *Cephalapodes.* We are indebted for much of this knowledge to M. Peron, who was so fortunate as to obtain the animal of *Nautilus spirula* in connection with its shell, and brought it, in that state, from New Holland. This animal, which appeared to be analogous with the *sepia*, had the shell not only attached to, but so let into its posterior extremity, as to leave a part of it only in view.

The near agreement of the internal structure of the shell of *N. pompilius* and indeed of most of these many-chambered shells, with that of

N. spirula; and the circumstance of the *Argonauta* being inhabited by a mollusca of this class, leave but little doubt that all these shells have been the solid appendages of similar animals.

The representation given by Rumphius, *d'Amboinsche Rar. Tab.* 17, *Fig.* c. of the dead animal of the *N. pompilius,* although of an animal which was much injured, not only gives the idea of a similar animal, and shows the appendage by which it was connected with the siphunculus of the shell; but also seems to bear that figure which authorizes the supposition, that part of the shell had been let into the body of the animal. This partial envelopement of the shell by the animal is also confirmed, as is justly observed by Lamarck, by the blanched appearance, which extends some little distance from the edge of the mouth of the shell of the *N. pompilius,* and which differs so widely from that which is yielded by the other external part of the shell, which is beautifully marked by transverse orange-coloured stripes.

LXXII. *Nautilus.* A spiral, many-chambered, discoidal univalve, with smooth sides. The turns contiguous, the outer side covering the inner. The chambers separated by transverse septa, which are concave outwards, and perforated by a tube passing through the disk.

The different chambers of these shells are very shallow, when compared with the last, which forms the opening, and which is, doubtless, the residence of the animal.

Whilst examining these shells, it is necessary to pay attention to that particular organization, by which a communication is kept up between the animal and the most interior part of the shell; since we shall not otherwise be able to judge of the peculiar modifications of these parts, which occur in the fossil remains of this and of other genera of this family.

Some have supposed the siphuncle of the nautilus to have been a rigid testaceous tube: thus M. Bosc says: "Toutes ces cloisons sont traversées par un petit tuyau cylindrique, epais, creux, imperforé latéralement, qui paroit composoit de petits tuyaux plus évasés d'un coté, et

implantés les uns dans les autres, et grossissant avec les cloisons." *Hist. Nat. des Coquilles, Tome V. p.* 164.

But that the tube in the nautilus was partly a membraneous tube, was known so long ago as the time of Hooke, who believed it to be a tube dilatable or compressible at pleasure ; and that, like the air-bladders of fishes, it served, by its expansion or contraction, to render the animal buoyant or not.

In the representation given by Rumphius of the dead animal which had inhabited the shell of *N. pompilius*, a round membraneous process is seen in the posterior part of the animal, which exactly agrees with, and had evidently been separated from, the siphunculus; and serves to show, that a connection existed between this part and the body of the animal.

In the dried recent shells of the nautilus, the membraneous part of the siphunculus is, I believe, seldom found, it being either removed by decay, or by the process of slitting the shell, to obtain the display of its internal structure : but I am pleased in being able to say, that frequently, in fossil specimens, not only is the existence of a continued siphunculus, extending through every chamber of the shell, proved, as in Plate VII. Fig. 12; but, that it is sometimes to be seen so much larger than the shelly part of the tube with which it is joined, as gives reason for supposing it to have been capable of a considerable degree of dilatation. This I am able to demonstrate in several specimens, as at Plate VII. Fig. 10, in which even the anatomy of this part may be ascertained.

It may be there seen, that the testaceous part of the tube, extending through about one fourth of the chamber, is formed by an elegant sinuous turning of the septum. It also there appears, that the membraneous tube which has proceeded from the animal is extended over the internal surface of the testaceous tube, is reflected a little on the exterior surface of the tube, and then returns and passes on to the inner surface of the next testaceous tube, and may thus be traced

on, in a similar manner, through all the compartments; it appearing to be a continued membrane, beginning with the animal, and extending to the first and smallest compartment; the end of each testaceous tube seeming to be included in a duplicature of this membrane, and placed on its outside, somewhat in the manner in which the abdominal viscera are involved in the duplicatures on the outside of the peritoneum.

We have thus, I trust, by the fossil remains of this genus, obtained a confirmation of the opinion of Hooke, and established the fact of a continued tube, capable of dilatation and contraction, passing through all the chambers of the shell. From what source the gaseous matter is derived with which this tube was filled, and in what manner the animal effected those modifications of the tube and its contained air, on which the variation of its buoyancy depended, are subjects of inquiry still demanding the assiduous attention of the naturalist, and on which I will not pretend to hazard a conjecture.

The power of raising or sinking the shell appears, from the observations just made on the siphuncular membrane, to depend on this organ alone: some other use remains, therefore, to be found for the closed cavities of the chambers. With these it is observable, that the animal preserves no communication, except for the passage of the siphunculus; he closing each chamber, and completely excluding himself from them, as he extends the siphunculus, and, as agreeable to the increase of his growth, he forms himself a new dwelling. Hence it appears, I think, highly probable, that the only use of the vacuities formed by these numerous chambers, is to counteract the weight of the increasing mass of the animal, and of the thick shell; and thereby to render the whole so nearly of the weight of the water, that the difference arising from the siphuncular membrane being contracted or dilated, may occasion the mass to swim or sink. It will, I trust, appear, in confirmation of this opinion, that in another genus of the multilocular shells, the belemnite,

another contrivance is adopted, apparently for the production of this effect—the rendering the weight of the mass so near to that of water, that a very slight change may occasion or destroy its buoyancy.

Should the opinions here offered be found to be objectionable, it may be considered, in excuse, that the economy of the animal has hitherto undergone but little investigation. So little, indeed, has the structure and the nature of the siphunculus been understood, that even De Bosc, the latest writer, perhaps, on the subject, points out no other use of this tube to the animal, than that of its serving to conduct its *tail* to the beginning of the spire. "Il n'y a pas de doute que ce tuyau ne serve a conduire la queue de l'animal a l'origine de la spire où elle s'attache." *Histoire naturelle des coquilles, Tome V. p.* 164.

We at present know, in a recent state, and of a size sufficiently large to allow of an examination of the structure, without the aid of a microscope, but one species of nautilus, *N. pompilius.* There is, however, no doubt of several distinct species existing in a mineralized state.

In Shepey Island, in the corresponding stratum of Brentford, in some parts of Somersetshire, particularly near Bath, and, I doubt not, but in several other parts of this island, a fossil nautilus is found, which, from the roundness of the back part of the shell, may be concluded to approach exceedingly near, at least in its form, to *N. pompilius.* Some of these, which have been found at Shepey, where they are mostly imbedded in septaria, as well as those which have been found at Brentford, are of very considerable magnitude, and seem to resemble *N. pompilius* in their internal structure.

The outside of these fossils are frequently resplendent, with a pearly coat. This circumstance demands some little consideration; since, as this is not the case with the outside of the shell of *N. pompilius,* it seems to point out the fossil as a different species, as the nacre does not exist on the outside of the shell of the recent species. Future observations will determine this question more decidedly; but at present, I am disposed to imagine, that, in the fossil specimens, the external part

of the shell may have been removed by decomposition; whilst the nacre, which has remained, in consequence of some peculiarity of structure or of composition, assumes the appearance of being the real external shell.

The nautilites of Shepey particularly engaged the attention of the late Mr. William Jones, who, speaking of those which are imbedded in *septaria,* observes: "When this shell *(Nautilus)* is found lodged in the waxen vein, a phenomenon is observable in some of the specimens, which seems the most surprising and unaccountable of any that occurs in this branch of philosophy. The stone is quartered irregularly into tali or cubes, by seams of a coarse yellow spar, of the colour of bees-wax, which intersect the stone in many directions: and what is wonderful to see, these seams of spar pursue their course through the substance of the nautilus, as if nothing had been interposed, though the shell is nearly as impenetrable as a flint. The case is very difficult, if we consider it as a penetration of the shell: but perhaps, when the shell was detained within the stone, it was obliged to part and crack, by the subsequent shrinking of the stone; so that when the spar filled the seams of the stone, it filled up the crevices of the shell at the same time. The insinuation of the spar through the siphunculus, and its forming a column within the chambers of the shell, is another remarkable circumstance. Upon the whole, the nautilus, thus inclosed, and affected by the waxen vein, is one of the most curious fossils in the world*."

In the neighbourhood of Whitby, situated on the sea-coast, in the North Riding of Yorkshire, a species of nautilites is found, which differs from the preceding in the back part of the shell, or of its turns being flat instead of round: so that the sides go off almost at a right angle from the back of the shell.

Between Bath and Bristol, in the neighbourhood of Keynsham, there is sometimes found another species, in which the back of the shell is

* Physiological Disquisitions, &c. by William Jones, F.R.S. p. 392. 1781.

actually depressed in its centre. A specimen of this species, which I possess, is a German fossil: the siphunculus, in this specimen, runs about midway between the middle of the chamber and its inner side. The line, Plate VII. Fig. 13, is that which is described by its posterior surface.

Breynius had observed, that all nautili did not agree in the form of their septa; and hence divides them into two orders: 1st. Those with concavo-convex semilunar diaphragms; and, 2dly, Those with jagged or sinuated diaphragms. Da Costa also, in his "Elements of Conchology," says, "I have seen fossil kinds with foliaceous sutures, like the ammonitæ; which implies, that all the species have not such regular roundish partitions." P. 168.

The fossil shell of this description which appears to be the most uncommon of those which I have seen, differing the most widely of any, not only from the recent, but from the other fossil nautili, is one, of which I purchased the remains at the sale of Dr. Menish's collection. Of the place where this fossil was obtained, I have no information. Its striking characters are, its great size, the situation of its siphunculus, and the peculiar form of its septa, and of course of its chambers. Plate VII. Fig. 15, is an outline sketch of this fossil, one-third of the size of the original.

The outermost septum in this specimen, which is not that which was the last, and consequently the largest, of the original shell, measures full nine inches in its longest, and seven inches in its shortest, diameter. But the most striking character which it offers to our observation is, the form of the septa; since these, instead of having a regular rounded sweep, as in the recent nautili, and in most of the fossil species, have an undulated form. This results from each septum forming a deep lobated process, extending backwards, on each side, over which process is hollowed out a deep sinuous notch, for the reception of the corresponding lobated process of the next anterior septum.

From the peculiar form of the chambers and septa in this fossil, an undulating or foliaceous suture is formed, which necessarily approximates it to the genus *Ammonites*, and prevents our regarding any longer this simple suture as one of the generic characters of *Nautilus*.

The siphunculus in the recent nautilus, I believe, always passes through nearly the middle of the septa. This is the case also with those nautilites of Shepey, which bear the general form of *N. pompilius;* and with those found at Brentford, one of which, impregnated with pyrites, is represented Plate VII. Fig. 12. But in other specimens, as in the one just noticed, it passes much nearer to the inner part of the shell. In others, again, it passes nearer to the outer part of the shell; and in one specimen which I possess, from Yeovil, Plate VII. Fig. 16, it is seen to run along the back of the shell. The septa, in these last specimens, frequently have an undulating direction; the fossil approximating, both in the situation of the siphuncle and form of the septa, to the *Cornu ammonis.*

It should be remarked, with respect to the size of the siphunculus, that, independent of the difference which may perhaps take place in the degree of dilitation of the tube, at the time of its becoming involved in its matrix, considerable difference may result from the section of a specimen by which the tube is displayed. Thus, if the longitudinal section of the siphuncle is made directly along its middle, it will necessarily display a wider opening than if the section had been made more to either side.

I am perfectly unacquainted with the nautilite without distinct chambers, or visible concamerations, mentioned under the article nautilite, by Bourguet, in his dictionary, on the authority of Spada, who describes it: "Nautilites unius aufractus, dorso subrotundo, squameo, reliqua corporis parte palmata." *Spada, Cat. Lap. Agri Veron.* p. 20. I am also ignorant of the fossil which the inhabitants of Maltha call *Capo di gatto;* and which Lhwydd describes as *Nautilitæ articulus, Lithoph.* No. 303. I should, however, suppose it

not to be the cast of a chamber, but a disengaged septum; some of which I have, I believe, from Shepey; and others, which I have reason to suppose to be foreign.

Plate XI. Fig. 25, is a minute fossil shell found on the Appennines, near to Sienna, by Thomas Meade, Esq. of Chatley Lodge, near Bath, whose kindness I shall have repeated occasion to acknowledge. This shell appears to be *N. crispus*, Linn. having lateral spires, with about twenty flexuous crenated joints in the exterior whirl, marked by elevated striæ; outer edge carinated; inferior volutions occult; aperture clasping the body; semicordate; furnished with a small perforation or syphon. *Testac. Britan.* p. 187. Plancus observes, that none of these beautiful fossils are found on the yellow sand of Bologna; but that they are very abundant in the sand of the mountain Covignani, in Rimini.

To the kindness of the same gentleman I am indebted for the opportunity of laying before you the minute fossil nautilus, Plate XI. Fig. 26, which is perhaps one of the species alluded to by Colonel Montague, as a very minute non-descript species, found with the other minute Sienna fossil shells. This is spiral: the inner turns concealed; the outward turn is wide toward the middle of the shell, where it is umbilicated; but very narrow at the back, and is formed of about fifteen chambers. I have but one specimen of this fossil, and am unable to discover any thing respecting its siphuncle. This shell is more minute than the preceding fossil, and in its general form very much resembles a reduced *N. pompilius*.

Considering the genus *Nautilus* of Linnæus as too comprehensive, and that *Nautilus* should contain only those spiral multilocular shells whose inner turns are concealed, and whose siphuncle is obvious; and that *Ammonites* should include those whose turns are apparent on both sides, but whose siphuncle is concealed; no genus is left for the reception of those minute shells which were discovered by Beccarius and Plancus, in which the characters of *Nautilus* and *Ammonites* are

blended, the turns being apparent on both sides, and the siphuncle obvious; but which have been generally considered as recent *Cornua ammonis.*

It is true that Lamarck says: "Les discorbes seroient de véritable nautiles, si leur tours de spire, au lieu d'être tous entièrement apparens et à découverts, etoient cachés par la dernier tour enveloppant les autres ou les recouvrant par sa paroi extérieure, et si elles ne manquoient de syphon. Si ces mêmes coquilles ayant leur tours de spires à découvert et bien apparens, avoient leur cloisons perforées par un syphon, elles seroient alors des spirolines*." But on referring to the genus *Spirolina,* this genus is found to have been formed for the reception of those minute shells, which, being partly spiral and partly straight, differ from those of the genus *Spirula,* only in having their spiral turns contiguous.

It therefore seems necessary to make a still farther separation, and to dispose of these shells, in which the characters of *Nautilus* and *Ammonites* are blended, under a distinct genus. This is the more requisite, since thus the error would be more plainly shown of considering these shells as ammonites, of which genus none have been yet found in a recent state. The characters of such genus—a discoidal, multilocular spiral univalve, with all the turns visible on both sides, and the septa pierced with an obvious siphuncle—seem to me sufficiently strong and distinct to authorize the formation of a separate genus, which might be marked by the term *Ammonautilus,* expressive of its mingled characters.

I shall not, however, presume on such a change; but having made these suggestions, will leave them under the genus *Nautilus.*

N. Beccarii, Linn. *Planc. Conch. min. not.* Tab. I. Fig. 1, claims the first notice, in consequence of its being the first discovered shell of this family, and that which gave rise to the supposition of the existence of recent *Cornua ammonis.*

* Annales de Mus. d'Hist. Nat. Tome V. p. 182.

The existence of these shells, in a fossil state, was known to Beccarius and Plancus, who found them in considerable numbers in the mountains not far distant from Rimini and Bologna. Plate XI. Fig. 27, is one of these fossil shells, brought from the Appennines, in the neighbourhood of Sienna, by Mr. Meade. The matrix is a yellowish spathose concretion.

The reversed variety of this species, or, as it is in general considered, the reversed species *N. beccarii reversus*, is also found in considerable numbers on the Appennines, along with the former. This reversed fossil shell is represented Plate XI. Fig. 28. The opposite side of the shell is here represented; but, being of a reversed shell, it runs in the same direction as Fig. 27.

Among the minute shells which Plancus considered as recent *Cornua ammonis*, were some which he distinguished as being bordered; since many of them, especially those which were whole, possessed a wide pellucid margin, which was spread round the whole shell. Whether all these shells were naturally thus bordered, and lost this border by the violence of the waves; or whether those which are bordered are of a distinct species, he attempts not to determine. *De Conch. min. not.* Cap. IV. Similar shells have been found fossil in the hills of Bologna and of Piedmont; and both the recent and fossil ones, he observes, are sometimes found as large as small lupins. App. I. p. 85.

One of these fossils, through the kindness of Mr. Meade, is represented Plate XI. Fig. 30. It appears to accord very nearly with *Nautilus subarcuatulus, Supp. to Test. Brit.* Plate XIX. Fig. 1, the separated convoluted portion of which had been taken for *N. calcar.*

LXXIII. *Spirula.* A multilocular shell, partly spiral and partly straight, the turns being disposed in a discoidal form, and separate from each other; the last turn being elongated, and continued in a straight line. The septa are transverse, regularly concave outwards, and pierced with a shelly tube: the opening circular.

This genus is very properly separated from *Nautilus* by Lamarck;

since, except in the form of the septa, and the disposition of the siphunculus, there is no concurrence of character. The fossil shells of this genus appear to resemble *Spirula fragilis*, Lam. *Nautilus spirulus*, Linn. very closely, except in size. In this respect the difference is so very considerable, the fossil shells being so much larger, as almost to warrant a specific distinction, founded on this circumstance alone. The fossil shells of this genus have hitherto been named *Lituites*, from their resemblance, in form, to a bishop's pastoral staff; but, in these pages, I shall denominate them *Spirulites*, in concordance with the name of the genus.

The siphunculus, in the recent specimens of this shell, differs from that of the nautilus, in being formed by one continued shelly tube, or by the smaller end of each anterior one terminating in the larger end of each posterior one; but whether this is constantly the case or not, in fossil specimens, I am unable to decide; since, in those specimens, in which I have discovered such appearances as would lead to a suspicion of the siphunculus being partly membranous, I have not been able to ascertain whether they were fragments of the spirulites or of orthoceratites. The very great length of the straight part of the shell, in the spirulites, will necessarily occasion this ambiguity, until some decidedly distinguishing marks of the orthoceratites and of the straight part of the lituites can be discovered. As in the nautilites, so in the spirulites, the situation of the siphunculus varies in different specimens, and perhaps in those which are in every other respect similar.

We have seen that, in the nautilus, the siphunculus is partly membranous and probably elastic; whilst, in the shells of this genus, we find that the whole siphunculus is of shell, and consequently unyielding. From this difference of organization, a considerable difference must necessarily exist, as to the influence which the introduction of water or of air must have on the buoyancy of the several shells: a difference depending on the greater quantity admissible in a dilatable than in a rigid tube. A more intimate knowledge of the nature of these shells

must be obtained, before we can form any opinion respecting the circumstances in the economy of the animals inhabiting them, which have demanded these particular modifications.

The fossil shells of this genus are, I believe, always found imbedded in a matrix, excepting those fragments of the straight part which are perhaps not to be distinguished from orthoceratites, the genus which must next employ our attention. Spirulites are found in chiefly a reddish marble, in Mecklenbourg, in some parts of Normandy, and, it is also said, in Switzerland.

But they are obtained, by far most frequently, from Gothland and Oeland: the latter place affording the finest specimens: those in which the spiral part of the shell is preserved are very rare. The one which is figured Plate VI. Fig. 11, is from Oeland, and was purchased from the Calonnian collection. In this specimen, not only are the spiral turns of the shell seen, but traces of the continuous shelly siphunculus also are evident, Plate VII. Fig. 18, in a dark red limestone, evidently containing a large proportion of iron; in which is displayed the spiral termination, and a small part of the straight portion of the last turn of one of these shells. Plate VII. Fig. 19, represents another of these fossils, imbedded in grey marble, from some part of Germany.

LXXIV. *Orthocera.* A straight or slightly bent, rather conical, multilocular shell; the chambers separated by transverse curved septa, pierced by a tube.

The shells of this, as well as those of the former genus, were placed by Linnæus under the genus *Nautilus;* the considerable difference, which is observable in their external form seems, however, fully to warrant their separation. Most of the shells which, though straight, have been considered by Linnæus, and other naturalists, as nautili, are minute and even microscopic shells; and, when sufficiently examined, some of them may be found to possess characters distinctive even from both those of *Nautilus* and *Orthocera.* These are, *N. ju-*

gosus, N. costatus, N. radicula, N. subarcuatulus, N. semilituus, N. rectus, N. spinulosus, N. legumen, and *N. raphanus.* But, obliged to observe certain limits, I shall not dwell, in this work, on those fossils which are so small as to be microscopic objects, except where it is required for the sake of particular illustration.

In reviewing the history of these fossils, we find many instances of the perplexity and confusion proceeding from an endeavour to ascertain the nature of a body, which cannot be referred to any known recent animal, as strictly analogous. *Gesner. de Figuris Lapidum*, Cap. XIV. p. 167, and Aldrovandus, *Museum Metallicum*, p. 732, considered them as the petrified tails of crabs; the former naming them *Cauda cancri, s, astaci fluviatilis;* and the latter, *Cancritæ.* But as the knowledge of fossils advanced, their resemblance to the alveolus of the belemnite was perceived, and they were considered by many as the alveoli of large belemnites, and therefore obtained the name of cylindrical alveoli. Some of these fossils were even considered as part of the vertebral spine of some marine animal: an excuse for which may be found in the particular forms possessed by some of these bodies. Our countryman, Lhwydd, did not make much progress in developing the nature of these fossils; he was satisfied with naming them *Alveoli;* and, of course, with considering them as the alveoli of large belemnites.

Scheuchzer, although not informed of the real nature of these fossils, very properly separated them from the belemnites. No correct knowledge, however, was obtained respecting them, until Breyn and Klein made them the objects of their investigations, and were led to the conclusion, that they were the remains of some marine, univalve, chambered shell. This opinion was soon confirmed by the discovery, by Plancus, of minute recent shells on the shores of Rimini, which appeared to possess the characters of orthoceratites: but no recent shells of this genus are known, except those which have been found in the sea sand of different parts, and which are so minute, as to be microscopic objects.

The shells of this genus, Plate VII. Fig. 14, like the nautili, are divided into chambers by septa, through which passes a tube or siphunculus, varying much in its form, situation, and size, in different specimens.

The surfaces of these fossils vary so considerably, as to form very striking differences, on which may be grounded their separation into different species. In some their surface is smooth, and in others marked by longitudinal or transverse striæ. The parts possessed by the chambers are in some marked, externally, by a considerable depression; whilst in others, these corresponding parts are distinguished by a slight degree of protuberance. They differ, also, with respect to their form; some being straight, while others are described as slightly curved at their smaller end.

Their size varies, from being, as has been just observed, so small as to be a microscopic object, as to equal the thickness of a man's arm. M. Walch observes, that they are sometimes nearly four inches in diameter, and more than an ell long, possessing nearly seventy chambers. A specimen now before me is full four inches in diameter. Dr. Wright describes an orthoceratite in marble, two feet four inches in length, in which were sixty-six partitions. *Phil. Trans.* Vol. XLIX. p. 670.

Some care is however necessary, before we determine on the actual form of such of these fossils, as, being imbedded, have had their parts displayed by section. If we suppose a spirulite thus imbedded, and a section commenced at its straight part, should the section not happen to be made on the same plane with that on which the spiral part is disposed, a part only of the last turn may be cut through, by which the straight part may be separated from the spiral, and the part of the last turn left with the straight part, might lead those who did not take this circumstance into consideration, to consider it as a bent orthoceratites. Indeed, so easy it is for mistakes to have been thus made, that I should be disposed to look with suspicion at all the sections of orthoceratites bearing this bent figure, were it not that ana-

logy authorizes the belief that such is sometimes their natural form; since this form is observable in many of the different species of the minute recent concamerated shells.

In none of the multilocular shells are such differences observable, with respect to the size of the siphunculi, as in this genus. In some the siphunculus does not equal one tenth, whilst in others it exceeds a third, and is sometimes nearly one half, of the diameter of the orthoceratite itself. It generally assumes that tumid form, which a membraneous part might be expected to assume, when dilated between the septa: as may be seen in the large siphunculus, Plate VIII. Fig. 2, and in Fig. 7, where the siphunculus is seen intersected by the septa of the orthoceratites; the whole being imbedded in a mass of whitish marble.

The siphunculus, or rather the cast of the siphunculus, of this shell, very often yields a striking appearance, from an obliquity in its form, as in Plate VIII. Fig. 2, and Fig. 6. This appearance has contributed somewhat to the degree of error which has existed, respecting the original nature of these bodies; since, even those who might be disposed to consider them as deriving their form from the siphunculus of an orthoceratites, might expect to find a corresponding obliquity of form in the orthoceratites itself. But a slight investigation will show, that there exists no reason for supposing, from this circumstance, that the shell to which it belonged possessed any particular degree of obliquity of form.

The septa, by which the siphunculus is intersected, being a segment of a hollow sphere, the divisions of the siphunculus must necessarily vary with the direction with which the siphunculus passes through them. If the siphunculus passes through the centre of the septa, and in a line nearly parallel with the parieties of the tube, it will be marked by segments of a hollow sphere, the sections of which are disposed in nearly transverse lines, as at Plate VIII. Fig. 3. But if the siphunculus does not pass through the centre of the septa, and yet keeps a line nearly parallel with the parieties of the tube, it will be marked

by segments of a hollow sphere, the sections of which will be disposed in oblique lines, as at Plate VIII. Fig. 4: the obliquity of the lines increasing with the increase of the distance from the centre. This obliquity, however, may not always depend on this circumstance; since, in some species, the septa themselves are disposed in an oblique, or rather undulating direction.

When it is considered, that of the recent spirula, very few are found with more than three or four concamerations of the straight part of the shell attached to the spiral, it is not to be wondered at, that the straight is so seldom found connected with the spiral part, in the fossil specimens. In consequence of this circumstance, some difficulty arises in determining which of the straight concamerated fossils are to be considered as having been of that form, whilst existing in their complete or perfect state, and therefore belonging to the genus *Orthocera;* and which are to be considered as having originally terminated in a spiral form, and which may consequently be considered as the remnant of shells of the genus *Spirula.* An instance of the confusion thus occasioned may be seen by comparing the representations, Plate VII. Fig. 14, and Fig. 19, *a.* The first of these figures, Fig. 14, represents a fossil, which has always been so much regarded as an orthoceratites, that if any one, who had studied these fossils, had been desired to point out one which was most decidedly an orthoceratite, and not a spirulite, he would have immediately referred to this fossil.

But the acquisition of the slab of marble from which the fossil represented Fig. 19, *a*, was taken, has determined, that such an opinion should be adopted with some reserve. It is a slab of light-coloured Oeland marble, in which the fossils are seen on one side, in their natural state, in relief; and, on the other side, their internal structure is displayed, in numerous sections, by the cutting of the marble. By an examination of the fossils on the rough part of the marble, as well as by examining some of the sections, it will be seen that they bear not only the exact form of the preceding fossil, Fig. 14, but possess

also a surface striated exactly in a similar manner. The correspondence is indeed so very close, as to render it a subject of future inquiry, whether these fossils are not of the same species. If this question were decided in the affirmative, then would it unexpectedly turn out that the fossil, Plate VII. Fig. 14, which has always hitherto been regarded as an orthoceratite, is really a spirulite; since, in another part of this slab, Fig. 19, *b*, an oblique section is seen, of one of these fossil bodies terminating in spiral convolutions. It is here proper to remark, that the spirulite in red limestone, Plate VII. Fig. 18, also has its surface marked in a manner very much resembling that of the assumed orthoceratites, Plate VII. Fig. 14.

These fossils are far from being very abundant; nor are they very generally diffused, being known, at present, to exist in very few places. They are said to be found in greatest numbers in Mecklenbourg, and sometimes in the neighbourhood of Francfort, where they seldom exceed the ordinary belemnite in size. They are also said to be found, though but rarely, in Switzerland. M. Gmelin found them in Siberia, and M. Zukert mentions them as existing in the marble quarries of Blankenbourg; but the greatest quantities of them are discoverable in the marble of Oeland, which, being of a reddish colour, and variegated by the different colours of these bodies, and of the spathose matter which fills their chambers, and being also susceptible of a fine polish, very often yields an extremely beautiful appearance.

Some of the pavement of Chelsea College, and of Hampton Court, is paved with slabs of this, and a grey marble; in which, when wetted, numerous sections of this fossil are discoverable. The grandest specimen which is, I believe, known, of this kind, is a slab, now in my possession, and which originally formed a part of the museum of Mr. Strange. In this specimen, a square slab of eighteen inches by thirteen, are contained more than fourteen longitudinal, besides numerous transverse sections, of different orthoceratites; showing, by the dif-

ferent directions in which the sections have been formed, the various structure of the several parts of these fossils.

I am not, of my own knowledge, able to speak of the existence of these fossils in Great Britain. They appear, however, from Lhwydd's catalogue, to be by no means rare, in different parts of Gloucestershire, Oxfordshire, Northamptonshire, &c.

It is exceedingly gratifying to me, to be able, through the kindness of Mr. Meade, to place before you a representation of a beautiful minute orthoceratite, brought by him from the Appennines, near Sienna. Plate VIII. Fig. 16, is the fossil of its natural size; and Fig. 17 is the representation of the same fossil, magnified by a single lens, for the purpose of obtaining a more distinct view of its structure.

Colonel Montague, alluding to a recent, minute, straight, chambered shell, varying in some respects from *N. costatus*, Linn. gives the following description of this fossil, which I take the liberty of introducing, not merely on account of its perspicuity and correctness, but because I could not myself have subjected a sufficient number to real inspection, without trespassing further than I wished on Mr. Meade's kindness.

" A most elegant shell of this kind is found fossil upon the Appennines, near Sienna, several of which we have been favoured with by Mr. Meade and Mr. Higginson. These vary a little; but the most perfect are an inch in length, completely cylindric, except at the last joint, which is rather larger, and terminates conically, ending in a small protuberance, nearly half as long as the joint to which it belongs; the anterior end of those which appear perfect, is a little contracted round, and smooth, or projecting beyond the ribs; in the centre is placed the aperture or syphon, whose margin is finely crenated.

" They vary also as much in the number of chambers as in that of the ribs; possessing from ten to fifteen of the former, and from nine to twelve of the latter; the joints are not much raised, but usually two or three at the anterior end more than the rest. The shell is extremely thick in proportion; and we found, by dividing several down

the middle, that the *septa* were equally strong, and each furnished with a small crenated perforation in the middle, but not a continued syphon: the cells are not round, but in the section appear rather concavo-convex. The colour is of a pearly white.

"May not this be a variety of the *N. costatus* of superior growth, occasioned by a more southern climate? But whether it is found at present in a recent or living state, we are ignorant." *Test. Brit. Sup.* p. 85.

LETTER X.

HIPPURITES......DALMATIAN AND VERONESE FOSSILS OF A SIMILAR APPEARANCE......BELEMNITES, OPINIONS RESPECTING.....SPECIES DESCRIBED.

LXXV. HIPPURITES. A straight or conical shell, furnished internally with transverse septa, and with two lateral, longitudinal, obtuse, and converging ridges; the last chamber being closed by an operculum.

The Baron Picot de la Peirouse first noticed these bodies, in a tour through that part of the Pyrenees which is in the neighbourhood of Monferrand and Jougragne, in the department of Aude, where they are known to the inhabitants by the name of Horns. He found them chiefly in a loose brown earth, and in the adjoining lime-stone rocks, grouped with a new species of fossil oyster, and various fossil coralline bodies. In consequence of observing that they were concamerated shells, he was induced to consider them as a new species of orthoceratites, notwithstanding that he discovered that they were furnished

with opercula, and that their internal structure was materially different from that of any orthoceratites which had been hitherto described*.

These shells, Plate VIII. Fig. 1 and 5, undoubtedly require to be considered as of a distinct genus from orthoceratites. Like orthoceratites, they are fossil, testaceous, conical tubes, more or less approaching to a cylindrical form, being sometimes straight and sometimes curved, and internally divided into numerous chambers by horizontal septa: but, unlike the orthoceratites, they do not appear to be provided with a syphon; the functions of this part having been perhaps performed by two converging ridges, which, at no great distance from each other, proceed from the sides of the cavity along its whole length. Soon after their origin, these ridges suddenly contract; and then, gradually becoming more tumid, terminate in rounded edges, at about a third of an inch from the sides. The gutter which is formed between these ridges is generally, like the rest of the cavity, divided into chambers by numerous transverse septa. Picot describes what he conceives to be the remains of a siphunculus, in two specimens; but the appearances do not appear to be such as to warrant the supposition. The representation of this specimen is, however, here copied from Plate II. Fig. 2, of Picot's work; Plate VIII. Fig. 5, *a*, marking the part in which the siphunculus is supposed to have existed.

The Baron Picot observes, that in several specimens the gutter, or space between the ridges, is entirely empty, or free from septa; but very properly remarks, that this must not be relied on as a specific distinction; since it is probable, that in its original state it was furnished with septa. Having very fortunately obtained some specimens of this curious and interesting fossil, and having amongst them two specimens, in which this part was thus empty, I carefully examined them, and was surprised at not finding the least trace of thc adhesions of septa on its

* Philippi Picot de la Peirouse de novis quibusdam Orthoceratitum, &c. Dissertatiuncula. Page 4.

side. A further examination with a lens, assisted in explaining this circumstance; since I thereby discovered, that the whole internal surface was beautifully frosted over with minute crystals of calcareous spar, which had most probably concealed the lines of attachment.

The operculum is sometimes convex, but in general it is concave. It is for the most part firm and solid, except on its upper part, where innumerable foramina are observable; being the openings of minute tubuli, which appear to enter into the composition of its superior part. Two larger openings are also observable, which, in their figure and situation, appear to correspond with the two internal ridges. Picot examined numerous specimens, with the hope of ascertaining the mode in which this operculum joined the mouth of the shell, not doubting that it was attached to the animal, who possessed the power of opening and of shutting it at pleasure. He found in every instance, that the edges of the opercula were so exactly adapted to the openings, as to allow of their being thus completely closed. In one instance only he found two projecting pieces on the lower surface of an operculum, which had somewhat of the appearance of the remains of an hinge; but never having observed any thing similar on any other specimen, he is disposed to conclude that this appearance was accidental.

Of the particular economy of the animal which inhabited this shell, we cannot form any correct opinion from the specimens which have been yet made known: nor can any satisfactory opinion be formed respecting the action of the operculum, or the use of the lateral ridges, until more perfect specimens have been discovered. Until then, also, must be deferred, the attempt to determine the specific distinctions of these fossils.

The Abbé Fortis appears to have met with some fossil bodies in Dalmatia, which might, perhaps, be classed among the hippurites. "Walking," he says, "about the habitations of Rogosniza, I happened to discover, in the hard marble rock, a curious fossil, very much resembling horns; and recollect to have observed, in the public Museum of Natural

History at Padua, a piece of the same species, under the denomination of *Cornu vaccinum*. I am, however, of opinion, that the ceratomorphous fossil of Rogosniza, as well as the other at Padua, are *Orthoceratites*, of which the species are now lost, or are the produce of more distant seas. You will probably say, that the name of *Orthoceratites* is but ill suited to a recurvous fossil, and I agree with you; so you may call it, if you please, *Campilocerates*." *Travels into Dalmatia*, p. 159.

Fossils, which I conjecture are of this genus, but of a different species from those described by Picot, exist in the neighbourhood of Verona. The figures of these fossils, given by Spada, in his *Catalogi Lapidum Veronensium Mantissa*, Tab. I. and II. agree very closely with some of those given by Picot. They are thus described by Spada: "Lapides monstruosi—basi subrotunda, in medio concava; margine plano, latitudine unc. V. longitudine unc. VII. cras. unc. II. jumenti ungulam repræsentantes, in conum fastigiati, tribus præsentim fasciis antiqua parte horizontaliter distincta, quarum unaquæque verticalibus lineis striata est, postica vero lineis pariter verticalibus donata."

"Reperiuntur etiam alii lapides supradictis fere similes truncati, et ungula destituti, fasciis lineisque horizontalibus insigniti."

The former of these, in Spada's figures, bears a very close resemblance to a horse's hoof; and the latter very nearly resembles the largest of the hippurites figured by Picot.

The specimen, Plate VIII. Fig. 1, copied from Picot's work, Plate VII. Fig. 1, shows one of these fossils of a frequent form, but of a smaller size than common, some of these fossils being at least four times the size of this specimen. In this figure the operculum is also seen, with its two openings. Some of these fossils are more of a cylindrical form, as in Plate VIII. Fig. 5, from Plate II. Fig. 2, of Picot's work. In this figure are shown, not only that part which is considered by Picot as the siphunculus, *a*, but the septa, in nearly their natural situation, and the ridges which project into the cavity.

We shall now proceed to the examination of the belemnite—a fossil

body, whose form, structure, and composition, have all contributed to render it one of the most perplexing puzzles which have engaged the attention of oryctologists.

LXXVI. *Belemnites.* A conical or fusiform stone, of brown radiating spar, generally terminating at the small end in a point, and having, at the larger end, a conical cavity, naturally retaining a conical testaceous body, divided into chambers, and pierced by a siphunculus.

Various names have been assigned to this fossil; many of which, derived from the ridiculous notions entertained by the vulgar, in the early ages, need only be mentioned. Such are, devil's fingers, *Spectrorum candela*, and *Idæus dactylus*, from their having somewhat of the form of fingers, and from being found on Mount Ida; and *Lapides lyncis*, from their supposed origin from the urine of the lynx. Ovid, alluding to this notion, says:

> Victa racemifero lynces dedit India Baccho:
> E quibus, ut memorant, quidquid vesica remisit,
> Vertitur in lapides, et congelat aere tecto.
>
> METAMORPH. Lib. xv. v. 413.

The colour of this fossil is generally brown, in different shades, but it varies much in its degree of opacity, in different specimens; some being so transparent as to allow the rays of light to pass through very freely, whilst others are nearly opaque. In their forms they display a still greater variety. Some are cylindrical, some pyramidal, and others fusiform. The smaller ends of some are pointed, of some rounded, and of others rounded in a certain degree, but terminating in an abruptly projecting point. Some writers have spoken of bent belemnites, but I do not believe that this form naturally exists. The supposition of their existence has, I believe, been founded chiefly on a belemnite figured by Lhwydd, *Lithophyl. No.* 1683; but Lhwydd describes the specimen as being compressed, and of course its bent form may be fairly attributed to violence. Some belemnites, and par-

ticularly the fusiform, have a longitudinal sulcus, and others have been seen with two; but what has been the use of these sulci is not known.

So perplexed were the earlier writers on this fossil, respecting its nature and origin, that they were even puzzled to ascertain under which of the natural kingdoms to place it. Not only the earliest writers on mineralogy considered it as originally belonging to the mineral kingdom, but even Woodward supposed it to be a stone, *sui generis*. Langius considered it as a stalactite; Libavius believed it to be indurated amber; and even M. de Costa supposed it to be a natural fossil, or *lapis sui generis*, composed of talc and spar, and compared its cavity to that of stalactites; adding—"As for that marine body, the alveolus, I cannot think otherwise than that it is of the *Nautilus* kind, which, at the concretion or formation of the belemnites, became accidentally lodged in its cavity, in the same manner as all other marine bodies became lodged in the various fossil substances we now find them in." *Phil. Trans.* 1747. Stobæus and Hellwing were of opinion that it was of vegetable origin.

Among those who conceived it to be of animal origin, we find no small discordance of opinion; some believing it to have been the horn, and others the tooth, of an animal. Of those who entertained the latter opinion, some supposed it to be the tooth of a crocodile, and others of a physeter; Lhwydd believing it to be the tooth a particular species of the whale, resembling the narwhal. Some were of opinion that it was the spine of a particular species of echinus. M. Titius conjectured it to be one of the extremities of a species of *Stella marina*. M. de la Tourette believed it to have been a species of *Polype;* and Waller and others a species of *Holothuria*.

Later oryctologists, particularly Rosinus, Erhart, Breyn, Klein, and Linnæus, have agreed, that this body must be considered as the remains of the chambered shell of a marine animal, the recent analogue of which is unknown. With this opinion M. Walch perfectly agrees, believing it to be supported by the circumstance of the nacre having

been discovered on the outside of some of these fossils, and by the marks having been seen of such a laminated structure, as is frequently observed in shells, whilst in a state of decomposition.

Targioni Tozzetti, as well as M. Fermin, both conjectured, that they had seen an animal which might be considered as the recent analogue of the belemnite. But the animals which have been described by these naturalists differ materially from each other, and neither of them appears sufficiently to agree with the belemnite to allow us to consider it as being analogous with it.

The opinion formed by M. Walch respecting the nature of this fossil, or rather of its original state, displays a considerable degree of ingenuity. According to his opinion, the larger and exterior part of the belemnite was a shell containing a viscous and gelatinous fluid, now rendered a spathose body; that to the superior part of this conical shell was attached the exterior part of the shell of the concamerated alveolus, in the upper chamber of which the animal lived, as in the *Nautilus* and *Cornu ammonis.* Through the septa dividing the chambers passed a siphunculus, which was connected with a small tube passing through the centre of the fluid contained in the external shell, and terminating in a small round projection, which existed at the point of the belemnite, but which in general is destroyed. *Monumens des Catastrophes*, Tome III. p. II. p. 212.

Some very ingenious conjectures on the growth of the belemnite were proposed by a very ingenious and active promoter of these inquiries, Mr. Joshua Platt, of Oxford, *Philos. Trans.* Vol. LIV. p. 38, in a paper which he named, "An Attempt to account for the Origin and Formation of the extraneous Fossil, commonly called the Belemnite." The conical cavity and its nucleus, (Mr. Platt observes,) are always proportioned to the bulk of the belemnite, but not to its length: some are four times longer in proportion to the alveolus than others. The apex of the conical cavity, where the alveolus is first formed, in some, runs up about half the length of the

whole belemnite; in others, not a sixth part of the whole: but the upper chamber is equally proportionable to the bulk, or circumference of the belemnite, of whatsoever size or shape, and is the seat or dwelling place of the animal that forms the belemnite.

Whoever (Mr. Platt says) considers the seam or sulcus in the belemnite, will, I think, conclude with me, that the outward lamina is formed latest, as in the cowrce, and that the seam or sulcus is caused by the several additional coverings or laminæ terminating there.——As the oyster strengthens its shell, and excludes its first habitation, by additional laminæ formed *within*, the belemnite incloses its dwelling, by adding new laminæ *without*. Mr. Platt supposes, that the animal growing larger, when in its first former cell, forms then a second cell or chamber, and at the same time covers the first cell, by forming the appendage or guard, which is the first stage of the belemnite. In forming the third cell, fresh laminæ or coverings are carried on, and so of the rest, the body of the belemnite gaining an increase of volume with each additional chamber.

The siphunculus of the belemnite, he observes, is always upon the verge of the chamber or cell; and, in this siphunculus, is a little gut or ductus, proceeding from the body of the animal, by dilating or contracting of which, the animal, it should seem, may go out or in to its cell at pleasure. This is the only stay which the animal has to secure its retreat. "But I cannot agree (he says) with the learned Dr. Hooke, that the gut, or ductus, passes through all the cells to the end of the spiral cone, either in this shell or the nautilus.——I am apt to think (Mr. Platt says) that this gut, or ductus, as well as the body of the creature, is capable of being extended very considerably, to serve all the uses of forming the belemnite, without leaving the siphunculus; and that the gut serves for the same purposes as the tendons of the oyster: the latter to open and shut the shell, the former to allow the animal to go out and in at pleasure. And as the oyster feeds altogether in the shell, by opening the verge, the belemnite (whose residence is in the great deep, which is seldom dis-

turbed) very likely goes out in quest of food, but travels only upon the guard or rampart, leaving a trail behind, as all land-snails do; which, hardening into a testaceous substance, increases the dimensions of the outer walls, both in length and thickness, from the cell or chamber, to the bottom, or point of the whole belemnite. The animal, in its progress and return, clasps the whole guard, as a snail does a small branch of a tree in the gardens; and where the two sides meet, there the sulcus is formed."

An objection offers itself to this opinion of Mr. Platt, which is, that the conical concamerated part is sometimes much wider than the spathose part of the belemnite: a circumstance which by no means agrees with Mr. Platt's conjecture. According to his opinion, the upper chamber should agree, in its circumference, with the upper, or widest part of the belemnite; the body of the belemnite acquiring a proportional accession of bulk on the formation of each superadded chamber. But, as may be seen, Plate VIII. Fig. 8, specimens exist, in which the circumference of the later formed chambers exceed, in their circumference, that of the widest part of the body of the belemnite: an incongruity which militates much against Mr. Platt's opinion, as to the formation and increase of this body.

Having now placed before you the opinions of these respectable naturalists, we will proceed at once to the examination of this fossil, and of the several parts which enter into its formation.

But few observations offer themselves respecting the concamerated shell of this fossil. That its first chamber was the testaceous receptacle of an animal, which in all probability was enabled, by its connection with the siphuncle, to vary its situation in the water, appears to be universally admitted. The siphuncle, in the specimens which I possess, pass through the side of the septa; and this is, I believe, always the case.

With respect to the enclosing brown spathose part, which is formed by radiating crystals, intersected concentrically, this is found to vary in its figure so much, as to authorize the assumption of such specific

differences as will lead to the formation of three species: *B. fusiformis*, *B. cylindriformis*, and *B. coniformis*. The first of these, *B. fusiformis*, Plate VIII. Fig. 13, is by no means a common fossil, except in a very mutilated state. Its general figure is fusiform. A receptacle for the alveolus exists in the upper part, in the form of a reversed cone, from the point of which the body of the fossil again swells, and continues of a compressed roundish shape, with a longitudinal sulcus, for an inch or two, when it terminates with a tapering point. The figure which is here given, is from a specimen, which is perfect only as far as the shading is carried, the upper part in outline being added from a fossil in the possession of Mr. George Humphries, of Leicester-square. I believe this species is chiefly found near to Stonsfield, and in the adjoining parts of Oxfordshire.

B. cylindriformis, Plate VIII. Fig. 10 and 14, is, I suspect, very rarely found in a state so perfect as the other species are. Fig. 14 is a fragment of one of these species, so split, as to give a very fair view of the alveolus, which is filled with white spathose matter: the belemnite itself is formed of the darkest spar that I have seen in any specimen of this fossil. Fig. 10 is part of one of the cylindrical species; but roundish at both ends; I suspect, from being rolled by the water. This fossil is here shown chiefly for the purpose of your noticing a very small linear channel, which is continued from the point of the alveolus, longitudinally, through the rest of the spathose substance. This is the pipe, or canal, of which M. Walch speaks, in his account of this fossil.

B. coniformis, Plate VIII. Fig. 15, shows the most common form of this fossil: the specimen is so broken, as to show also the form and situation of the concamerated shell, in its alveolus. The chief varieties observable in this species are those depending on their colour, and their being more or less suddenly pointed, as Figures 11 and 12.

They are found of various sizes; from less than that of a goose-quill to a foot in length, and two inches in diameter. Baier says, "Maximi belemnitæ raro deprehenditur integri: habeo autem ingentia frag-

menta, ex monte Heimburgensi, quæ evidentur arguunt, lapidem ejusmodi, si integer esset, octo uncia fore longiorem, cum interim summa crassities in ambitu quatuor uncias cum dimidia omnino expleat." *Oryctogr. Noric. p.* 35.

A specimen which I possess, in two fragments, the superior of which is represented Plate VIII. Fig. 8, measures nearly twelve inches, and must have been, when perfect, upwards of fifteen inches in length: its circumference, in the thickest part, is five inches and a half, and the concamerated cone is nearly six inches in length.

Frequently, on one side of the belemnite, a slight and narrow groove is observable, as in Fig. 13: and in some specimens two, and even three of these grooves, are seen. How far these may be considered as giving a claim to specific distinctions, or whether they should be regarded as only the marks of varieties, cannot perhaps be at present determined.

The structure of the concamerated part of the belemnite leaves not a doubt that, like the nautilus, it was sunk or raised in the water by the different modifications of an appropriate organization. But it yet remains to endeavour to determine the original state and nature of that organization, and particularly of that spathose body of which the belemnite is chiefly constituted.

The opinion of M. Walch, that it was originally a gelatinous fluid, is the only conjecture that I am aware of, which has been hitherto hazarded respecting the nature of the substance of which it was composed originally. To confirm this opinion, it would be necessary to show that there had existed a shell, or some covering, by which this fluid had been inclosed and kept together. This circumstance has been supposed by several, and has indeed been assumed by M. Walch; but a close attention to the several statements which have been made on this subject, and a careful examination of every specimen which has come within my reach, has convinced me that no solid reason appears in support of its existence.

Delusive appearances are undoubtedly frequently observable, from which the presence of the remains of shell may be likely to be inferred. But these, on close examination, will be found to be entirely occasioned by the decomposition and successive exfoliation of the laminæ of the spathose substance, of which this body is composed; and which, in many parts, will be found assuming even somewhat of the iridiscent appearance of mother-of-pearl. Not finding reason for believing in the existence of the shell, or of the supposed contained fluid, I anxiously endeavoured to discover in what other state this part of the belemnite was most likely to have existed, during the life of the animal.

Satisfied that the use of the closed chambers, in all the multilocular shells, was to bring the animal to which they were appended, with its shell, to a degree of specific gravity, so near to that of water, as to render it capable of being raised or sunk with facility by the apparatus of its siphuncle, I concluded that this part of the belemnite must have existed in such a state, as by its lightness, it must, like the closed chambers, have served as a float to the animal. I had long entertained this opinion, before I had made those examinations into the nature of the spines of echini, and into the mineral changes of which they were susceptible, by which I learned how much the crystallization of the impregnating matter would be affected by even a small difference in the nature of the substance mineralized. Thus I learned, that a spine of an echinus of one species became a mass of opaque, white, rhomboidal crystals; and one of another species became a mass of dark brown crystals, of considerable transparency, appearing, at the transverse fracture, to radiate from the centre, the radii being divided by concentric intersections.

The general appearance of the crystallization of this latter species of spines appearing to be exactly that of the belemnite, it seemed to be fair to suppose, that there must have been a close agreement between the substance of this species of spine, and that of the belemnites, in their original state.

On examining the recent specimens which accorded with this fossil

spine, and which, as has been already mentioned, were of the palisadoe kind, the substance of which they were composed was found very much to resemble cork in its general appearance, and even in its structure, being so light and porous as not to allow them to sink in water. This, it will at once be seen, would be the kind of substance which would be particularly well calculated to perform those offices which we may presume would belong to the supposed corresponding substance in the belemnite. Hence I feel little hesitation in concluding, that the spathose part of the belemnite was originally a light pithy substance, by which the animal and its appendage were so poised in the water, as to be readily susceptible of those occasional changes in situation which the organization of the siphunculus seems to have been capable of producing.

It is in favour of this opinion respecting the original structure of the belemnite, that on immersing a belemnite in a very weak mixture of muriatic acid and water, in the proportion of about twelve drops to a pint, several exceedingly delicate membranous *flocculi* became evident, hanging from the mass, and waving with the fluctuations of the fluid. The notion, then, which we seem to be authorized in forming, respecting the previous state of the belemnite, is, that it was a conical concamerated shell, imbedded in a light porous body: a siphunculus passing through the septa, and perhaps terminating in the cellular part: the ascent or descent of the animal, with its dwelling, depending on the admission of air or of water into the siphunculus, and perhaps into the cellular part of the light body itself. This connection of the siphuncle with the light porous body is however assumed, on the existence of the tube passing through this body, as described by M. Walch, and which is discoverable in the specimen represented Plate VIII. Fig. 10.

It is hardly necessary to observe, in favour of the marine origin of the belemnites, that they sometimes have other marine bodies, such as oysters, serpulæ, &c. attached to their surface. This circumstance is,

however, worthy of notice; since it serves to show, although perhaps not decidedly, that the belemnite is not a nucleus, which was contained in a shell, but that it now possesses the same surface which it did in its recent state. This is, however, more plainly evinced by the specimen, Plate VIII. Fig. 9, in which this substance has been eroded, and apparently by some insect, to a considerable depth. That this was effected previous to its existence in a spathose state, cannot be denied to be most probable; and if the substance had been gelatinous, and contained in a shell, these erosions could only have been of the shell, and consequently exterior. This circumstance, therefore, is strongly in proof of this part of the belemnite having been a solid substance, capable of admitting the attacks of an insect, and of bearing the marks of the injury.

De Luc and Lamarck very ingeniously suppose, that the belemnite itself was contained within the body of the animal, in the same manner as the bone of the sepia or cuttle-fish. This opinion is far from being without probability; but it does not appear that, at present, we possess any means of forming a determination on this point.

The *Belemnite* deserves to be placed among the earliest fossils, not only from the recent belemnite being, in all probability, lost; but from the fossils with which it is in general associated, the *Cornu ammonis*, *Encrinus*, &c. having also outlived their recent analogues.

M. Walch doubts the existence of silicious nuclei of the belemnites, He says: "Que la noyau pierreuse de la bélemnite puisse parvenir à un si haut degré de dureté qu'elle donne du feu lorsqu'elle est frappée avec l'acier, c'est du quoi nous doutons beaucoup. Worm, Lange, Brukman, et d'autres l'ont soutenu, mais probablement ces naturalistes ont confondu avec les bélemnites une sorte du pierre à feu, qui leur resemble parfaitement et que l'on trouve dans la craye. *Monumens des Catastrophes, &c. Tome.* II. *p.* 229. That the cast of the conical cavity of the belemnite may be of such a degree of hardness, there can, however, be no doubt. I possess one, which is completely silicious; and

which bears, externally, the ridges corresponding with the concamerated structure of the shell.

I have never yet seen any other part of the belemnite in a pyritous state, except the concamerated part. In one specimen, the spathose part of the belemnite is imbedded in a mass of pyrites, with a pyritified *Cornu ammonis;* but it does not appear to have undergone any change, by metallic impregnation.

The matrix, in which these fossils are found, is generally calcareous; sometimes chalk, but most commonly limestone. Some of the marbles of Altdorff are chiefly formed of these bodies, and are thereby rendered of a dark brown colour. In a specimen before me, formerly in the Leverian Museum, the marble appears to be chiefly composed of these bodies, mixed with a few other marine remains; and in one part of the polished marble, a section is displayed of the concamerated part, showing distinctly the several chambers and partitions. Sometimes, but much more rarely, the belemnite is found transfixed in common flint, a specimen of which is figured Plate IX. Fig. 1.

That these animals must have existed in very considerable numbers, in the former world, is very reasonable to conclude, from the very wide extent over which their mineralized remains are now found. Lhwydd appears to think, that in England they are so abundant, that Cambridgeshire only is destitute of them. Besides the proof of their general diffusion, from the various parts of the world from which those have been obtained which we find in the cabinets of the curious, we have particular descriptions, in the writings of different oryctologists, of the several fossils of this description which have been found in Saxony, Swabia, Franconia, Brunswic, Salzthal, Goslar, Calenberg, Hildersheim, Potsdam, Niendorp, Lubec, Angerbourg, Francfort, Switzerland, Spain, France, and Great Britain.

LETTER XI.

AMMONITES.........BACULITES.........HAMITES.........SCAPHITES
TURRILITES.

LXXVII. *Ammonites.* A discoidal, spiral, mutilocular shell, with turns contiguous, and all apparent on both sides: the chambers divided by sinuous septa, pierced by a siphunculus, difficult to be traced, and never passing through the middle of the septa.

The shells of this genus are distinguishable from those of *Nautilus*, by the difficulty of detecting the siphunculus, but chiefly by their turns being all apparent on both sides.

These are among the fossils, which, from their extraordinary forms, and the frequency with which they have been found, have particularly excited the curiosity of the vulgar; to gratify which, superstition has lent its aid, by furnishing the tale of their being petrified snakes. Thus the nuns of Whitby

> "..................................told
> How, of thousand snakes, each one
> Was chang'd into a coil of stone,
>   When holy Hilda prayed;
> Themselves within their holy bound,
> Their stony folds had often found.
>
> Nor did Saint Cuthbert's daughters* fail
> To vie with these in holy tale.

* The Nuns of Lindisfarn, or of Holy Island Monastery

...............on a rock, by Lindisfarn
Saint Cuthbert sits, and toils to frame
The sea-born beads* that bear his name.
Such tales had Whitby's fishers told,
And said they might his shape behold,
And hear his anvil sound :
A deaden'd clang, a huge dim form,
Seen but and heard, when gathering storm,
And night were closing round.

MARMION, Canto II. v. 13 and 14.

Among the notions which have been entertained respecting these fossils, none is more curious than the following: "The country people retain a conceit, that the snakes, by their breathing about a hazell wand, doe make a stone ring of blew colour, in which there appeareth the yellow figure of a snake; and that beasts which are stung, being given to drink of the water wherein this stone has been soked, will there-through recover. There was such a one bestowed on me, and the giver avowed to have seen a part of the stick sticking in it: but *Penes authorum sit fides." The Survey of Cornwall, written by Richard Carew, of Antonie, Esq.*

These, and various other idle tales, had long supplied the place of rational conjecture, respecting the original mode of existence of these fossils, until, by the investigations of Lister, Buttner, Scheuchzer, and particularly of Breyn, their real nature was discovered; and it was fully ascertained, that they were the mineralized remains of a shell, the recent analogue of which was unknown.

Plancus indeed discovered, in the sand of the Riminian shores, microscopic, spiral, multilocular shells, which he considered as minute recent shells of this genus, and which have been considered as such by almost every writer on these subjects, since his discovery. Similar shells have been found in several parts of the world, and even on the shores of this

* Trochites.

island: but all these minute shells differ so essentially from the fossil shells of this genus, as to fully authorize the arranging of them under distinct genera.

The number of species in the genus *Ammonites* must have been exceedingly great. Langius and D'Argenville, indeed, are very restricted in their enumerations; the former giving fifteen, and the latter only fourteen, as the amount. Bromel ascertained the existence of forty species, and Scheuchzer extended the number to a hundred and forty-nine; whilst the assiduous Rosinus was led, by his inquiries, to believe them to be not less than three hundred.

To form a fair opinion on this point would require the examination of several collections, where these fossils had been collected with a particular view to this investigation. I am, however, satisfied that Rosinus's number is that on which we may with most safety depend; for, independent of the vast differences observable as to size, the various markings on the sides of these fossils are sufficient to characterize a great number of species. Thus we have smooth, knobbed, striated, and grooved. Those which are ornamented with knobs, vary according to the intermixture of these, or the order in which they are disposed. Those which are striated, as well as those which are grooved, derive a vast variety of embellishment from the striæ or grooves being straight or undulating, or partly straight and partly waved, from being bifurcated, trifurcated, &c.; or partly simple, and partly furcated. The species resulting from each of these must, it is evident, be very numerous; but from the several intermixtures of, or changes among, these different markings, the number must necessarily become exceedingly great. But besides the numerous species which are thus formed, a prodigious number more may be reckoned from the different markings and forms of the backs of these shells, on which are also exhibited every embellishment, almost, of which such a surface is susceptible. When it is considered that each of the modifications of form, of the sides of the shell, may be combined with every different form which is assumed by the back; and that the number of species thus yielded will be the number

of the different forms of the sides, multiplied by the number of different forms of the back, the number of species will be found far beyond expectation.

The number of species is, however, not confined by even these limits; since colour, another source of change, and of multiplication of species, remains yet to be considered. It is true, that of this source we cannot avail ourselves in the enumeration of fossil shells; but it is certainly fair to examine how far it may have been likely to have multiplied the number of species of this shell, in a recent state, which, in a fossil state, and without this addition, we have seen to be so very numerous. In the genus *Conus*, Linnæus admits seventy-one species; and in the genus *Cypræa*, one hundred and fourteen species: and, in both these genera, the figure of the shells so approximate to uniformity, as to allow it to be said, that the chief of the specific distinctions which have been had recourse to in them, have been those of colour, varying in its hues, and in the forms in which it has been disposed. Reckoning, therefore, upon the still further multiplication of the species of this genus, by distinctions arising from the various differences, as to colour, combined with the numerous distinctions as to figure, it may be concluded, that the number of species comprised in this genus, in a recent state, must have been immense; although at present we know not of the existence of a single individual!

Besides the markings observable on these fossils, which may be thought worthy of being regarded as specific distinctions, there is another kind, which is common to the whole genus, suffering some little variation in different species. These are the elegant undulating markings on the surface, which are named foliaceous sutures, and which are seldom observable but where the external shell is removed. Unlike the septa of the *Nautilus*, the septa in the shells of this genus are always extended in a peculiar sinuous form; so that, on the removal of the external shell, those edges of the septa, which terminated in the parietes of the shell, appear in very elegant forms, similar to those of a beautiful foliage, as is represented in the pyritous specimen, Plate IX.

Fig. 7, from Folkstone. The internal arrangement of these septa will be understood from Fig. 9, where a section of the same fossil is shown.

From this sinuous disposition of the septa, the chambers necessarily derive a very peculiar form: a form hardly to be described; but of which a correct idea may be obtained from the figure Plate IX. Fig. 3, which is a representation of one of the casts which are sometimes formed in the chambers of these shells; the surrounding shell having been removed by decomposition, subsequent to having been filled with the matter of which these casts are formed. These casts of the chambers of the *Cornu ammonis* are distinguished by the name of *Spondylolithes.*

In the quarries of Wet and Dry Sandford, in Oxfordshire, are frequently found fossils of a very curious appearance, being the series of casts, in the chambers of this shell, formed of spathose matter, the shell itself having been totally removed. In these fossils, which bear the general form of the shell, the casts of the chambers, though actually distinct, are so closely locked into each other, as frequently to render their separation very difficult. They are known among the quarrymen by the name of jointed snake-stones.

I have two specimens from Wiltshire, in which the *Cornu ammonis* has been imbedded in flint, and in which the terminations of the septa are still to be seen, now formed of flint.

The terminations of the septa are very beautifully preserved, in snow-white filaments, in some of the silicious specimens from Blackdown. Some of these specimens are rendered particularly interesting by the conservation of the outer shell, now a white silicious substance, and apparently the thickness of the original shell. A species of *Ammonites,* found at Yeovil, which is filled with a very fine white lime-stone and spar, yields a very beautiful appearance, when the outer surface is so far rubbed down, as to show the elegantly meandering lines of the sutures, as they reach to the surface.

The part of the *Cornu ammonis* which next particularly demands our attention is the siphuncle; and which has hitherto been so rarely made out, as to have led many to doubt whether it existed or not. Its existence being, however, proved in several specimens, analogy leads us to conclude that it really exists in all; and that it served the same purposes as the siphuncle in the *Nautilus*, the enabling of the animal to regulate its ascent and descent in the water.

The spondylolite, Plate IX. Fig. 3, strongly proves the existence of the siphuncle, by the deeply-sunk circular cavity which exists on the outer side of this fossil body, where, doubtlessly, the siphuncle had passed. In the very rare specimen, Plate IX. Fig. 4, which formed a part of the Leverian collection, the siphuncle itself is seen, *in situ.*

The situation of the siphuncle is not always the same, in every species: in some, it runs along the back of the shell, as in the specimen Fig. 3; in others, it runs along the inner part of the whirl, as in the specimen represented Fig. 4; and, unless I am very much deceived, a siphuncle runs along both the outer and inner side of the whirls of the specimen, Fig. 5.

The exact figure of the siphunculus is not, I believe, yet known. I have destroyed many specimens, with the hope of obtaining information in this respect; but without decided success. In general it appears to be formed by a uniform cylindrical tube, regularly increasing in size as it proceeds from the central to the outer whirls. I think, however, that in some parts of the specimen, Plate IX. Fig. 5, the siphuncle seems to be a little contracted in those parts where the septa unite with the outer shell; but that, in other parts, the septa appear to be formed of two shelly plates, which, separating as they approach the outer shell, seem to admit a duplicature of the siphuncle to dip in between them. Some of this appearance may however be a *deceptio visus*, proceeding in some measure from the direction in which the parts are divided.

Bertrand, *Diction. des Fossiles*, p. 175, and others, who have been

aware of the existence of this siphuncle, have yet supposed that this animal has been always obliged to remain, with its shell, at the bottom of the sea. But if this were the case, it would seem as if the animal had been supplied, in the siphunculus, with a useless organ. But it is most probable that, as in the *Nautilus*, the weight of the shell and of the animal, was so nearly balanced by the numerous cavities of the shell as to allow the animal, which, like the nautilus, filled the first chamber, to raise or sink itself at pleasure, by the alteration of the gravity of the mass, by occasionally filling the siphuncle with air, or perhaps with water. Those who doubted of the *Cornu ammonis* having possessed this power, have been chiefly misled by a mistake respecting the weight of the shell; and seeing shells of this genus of the size of the fore-wheel of a chariot, and weighing upwards of a hundred pounds weight, have supposed that they must necessarily have always remained, whilst living, at the bottom of the sea. But from every specimen which I have examined, it appears, that the shells of this genus must have been so thin and light, as to give no difficulty to the supposition, that with so many closed cavities, and the siphuncle itself, containing air, the shell, with the animal, would float, and would only sink upon the admission of water into the siphuncle, or upon its close contraction.

The shells of this genus, like those of *Nautilus*, had a covering of nacre, or mother-of-pearl, on their internal surface. But this nacre appears to have differed from the mother-of-pearl of those shells, of which recent analogues exist, in manifesting a much greater variety and brilliancy of colour in its mineralized state. It is this pearly coat of the *Cornu ammonis* which forms the brilliant flame-like spots, which render the marble of Carinthia *(fire-marble)*, so resplendent; and which, with the various beautiful hues with which they are blended, enables that substance to vie in beauty with the opal itself. That the nacre of the *Cornu ammonis* differed from that of the *Nautilus*, is, I think, evident, from the fossil nacre of the latter never displaying

an equal degree, nor indeed a similar kind, of brilliancy with that of the former shell. I have several specimens of fossil mother-of-pearl from the *Nautilus;* but, where the colours are not entirely lost, the appearance is exactly similar to that of the recent substance.

Specimens of the *Cornu ammonis*, on which the brilliant nacre still exists, are sometimes found. At Broad Marston, as we are informed by Dr. Maton *, a stratum was found, in 1778, containing a congeries of *Cornu ammonis*, on which the nacre is still visible: and indeed, on some of these, the brilliancy of colour possessed by the nacre is very considerable. The finest British specimens of this kind, which I have seen, are in the valuable collection of Mr. Harcourt, of Stapleton.

But the specimens which display the most vivid colouring, are those which are found near the river Moscorcica, about a league from Moscow. In one of these specimens, which I obtained from Mr. Heuland, the colours are not less splendid, nor less beautifully changeable, than those which the fire-marble itself displays, and are finely disposed over the whole of the shell. In another specimen, either from France or from the neighbourhood of Moscow, the colour is the richest blue I have ever seen.

Such of these shells as are found in schistose strata have generally suffered from compression; as is mostly the case indeed, with all organic remains which have been thus preserved. This is particularly the case with the ammonites which are found at Watchett. In these specimens, it often happens that the whole substance of a large shell is compressed into the thickness of a quarter of an inch. In ammonites which have been thus preserved, the shell is sometimes of a dead opaque white, whilst in others it reflects the most beautifully-coloured rays.

The specimen represented Plate IX. Fig. 8, and which is, I believe, foreign, is very interesting, not only from its figure, but from its retaining a considerable portion of the original shell. Specimens of this kind are extremely rare; for, in general, those which exhibit brilliant

* Dr. Maton's Tour to the Western Counties of England, Vol. I. p. 21.

colours have only the internal nacre of the shell adherent; and not as in this, and in one other calcareous specimen, which I possess, the whole substance. In some small specimens with which I have been favoured by the Rev. J. R. Cleeve and Mr. Clarke, the cavities are filled by a transparent calcedony; whilst the external opaque silicious substance yields every appearance to warrant the supposition of its being the shell itself, thus changed by impregnation with silex; for, although the change is such, as to have given transparency to the mass, the smooth shelly surface is evident.

Plate X. Fig. 6 and 7, are the lateral and front views of a beautiful fossil, which the late Mr. Martin, in his admirable work, ***Pertrificata Derbiensia***, Pl. 40, Fig. 1, 2, gives, rather hesitatingly, as a nautilites, with this description—"A fossil shell. The original a *Nautilus*. Involuted, somewhat globose, imperforated, striated; the striæ close, acute, transverse, but oblique on the sides, and united by a single, narrow, dorsal line, at the ambit. The mouth or aperture large, and somewhat extended on each side. The form and situation of the dissepiments unknown. Now and then found in our lime-stone, but not frequent." I have rubbed down this fossil at the mouth, but without being able to ascertain any thing with respect to either septa or siphunculus; and, of course, without being able to determine its genus.

Plate X. Fig. 8, is a fossil shell of a very rare form. It is rather globose, and marked with numerous transverse furcated lines, and three deep grooves, which surround the whirl, and terminate on each side in a small, but deep umbilicus. It possesses the character of *Ammonites,* in having small and frequent foliaceous sutures, with, of course, sinuous septa, and the character of *Nautilus,* in the outer turns, involving the inner. With the *habitat* of this shell I am unacquainted.

In another fossil from Italy, six times the size of the preceding, and much flatter, an exact agreement with the preceding exists, except that it is flatter.

Plate X. Fig. 9, is a fossil, which is also of an ambiguous appear-

ance. The whirls are narrow, but deep, and marked with frequent transverse ridges, which bifurcate at their origin: a deep rounded groove seeming to terminate the first whirl. A similar termination of the first whirl is observable in the fossil, Fig. 10, to which fossil it somewhat approximates.

Different opinions have been entertained with respect to the ammonites assuming naturally an oval shape. Whilst this has been said to be the case by some, who have adduced specimens of this fossil in this form, in proof of their assertions, others have contended, that the oval figure has proceeded from compression. The only specimen in this form, which I for some time possessed, was entirely pyritous; and by observing that a part of the specimen retained the appearance and proportions of a round specimen, I hesitated at admitting the proof of the fact, from that instance. Since then, I have seen oval specimens, indubitably possessing their original form, from Wiltshire; and have lately obtained one myself from Steyning, which is represented Plate IX. Fig. 6, and proves, undoubtedly, that shells of this genus existed originally in this shape.

LXXVIII. *Baculites.* A straight, cylindrical, or slightly conical shell, divided into chambers by transverse, sinuous, and imperforated septa; the articulations, or sutures, being indented in the manner of the battlements of a tower.

The fossil, the characteristics of which are here given, was found by Faujus St. Fond, among the fossils of St. Peter's Mountain, and was by him considered as a straight *Cornu ammonis*. *Histoire Naturelle de la Mont. de St. Pierre*, p. 140. The propriety of forming with it a distinct genus, as Lamarck has done, is obvious; since, on the same principle that St. Fond would name it *Ammonites rectus*, we ought to place the orthoceratites under the genus *Nautilus*, and name it *Nautilus rectus*, as has been done by Baron le Hupsch, who has given a figure of this fossil (*Baculites*) accompanied with observations on its structure, and on the relationship which it bears to the *Cornu ammonis*. *Nouvelles*

Découvertes de quelques Testacées Petrifiés rares et inconnus, pour servir a l'Histoire Naturelle de la Basse Allemagne, Pl. IV. This fossil was figured by Langius, *Hist. Lap. Fig. Helv.* Pl. 21, Fig. 4; and the figure of Langius has been copied by Bourguet, *Traité des Petrifications*, Fig. 316.

Both the specimens of this fossil, discovered by Baron de Hupsch and by Faujus St. Fond, are merely casts of the chambers of the shell, *Spondylolithes;* and such also is the specimen which I have also had the good fortune to obtain from Maestricht, and which is represented Plate IX. Fig. 2. This fossil, it may be observed, approaches nearer in size to that of Langius, than to that figured in Faujus St. Fond's elegant work. I must here remark, that the absence of a siphuncle, assumed by Lamarck, cannot be proved from the mere casts of the chambers, which is the only state in which we have yet seen this fossil.

It is about five years since I first met with the fossil represented Plate X. Fig. 1, with some others, at the shop of Mr. Heslop, who had received them from the coast, not far from Dover. Since that time I have been favoured, by my friend Mr. Herbert, with other specimens, from the same coast, on some of which are remains of the original pearly part of the shell. From a comparison of these fossils with the *baculites* of Lamarck, it appears that the chief difference is, that the septa of the *baculites* are disposed in a straight transverse direction, whilst in these fossils they are placed in an oblique transverse direction. Among these fossils were some which were slightly bent at their smaller end, as at Plate X. Fig. 2; and others so much so, as to show that this was their natural form, and not the effect of accident.

For fossils bearing a character so completely distinct, the necessity of forming a new genus seemed to be obvious, and analogy appeared to support the arrangement. As there is a genus *(Orthocera)* of straight multilocular shells, with plain septa; so there appears to be a corresponding genus of straight multilocular shells with sinuous septa, forming the genus *Baculites.* And as there are two more

genera in those shells with plain septa, one spiral *(Nautilus)*, and another partly straight and partly spiral, *(Spirula)*; so, of these shells with sinuous septa, we have the spiral *(Ammonites)*, and the partly straight and partly bent, which have not been yet noticed, and which I shall venture to place under the following genus.

LXXIX. *Hamites.* A multilocular hook-formed shell, with sinuous septa, with no evident siphunculus.

The uniform figure of these fossil shells sufficiently separate them from every other genus; and undoubtedly this separation would have been made long before this, if sufficient attention had been paid to the real forms which the fragments of this fossil possessed; and if a sufficient number had been obtained to have allowed the making of the necessary comparison.

One circumstance has particularly tended to mislead those who may have been induced to make any inquiries on this subject. All the casts of the fossils of this genus which I have met with, except one in sandstone from Wiltshire, are formed of a pyritous clay, which, when the shell has been entirely removed, so readily gives the idea of having been in a soft state, that the hooked form of the specimens have been attributed to their having been bent and distorted whilst in that state. Such an idea might even be readily excited by the specimen, Plate X. Fig. 5, found in the stratum of green sand in Wiltshire. Plate X. Fig. 2, shows a specimen, in which the first approximation to the hooked form is observable. Plate X. Fig. 4, represents a specimen, in which the turn of the hook is completely made; and evidently in such a direction, as could not have allowed of the formation of a spiral turn. In this specimen, enough of the smaller end of the fossil is left to show, that it was continued in a straight direction from the bend. This, it may be observed, is the termination in which alone we could have expected the spiral turn; but which, going off in a straight line after the bend, determines the hooked form to belong to this fossil.

The specimen Plate X. Fig. 3, which I purchased from the Le-

verian Museum, and which had frequently been with me an object of admiration, seems to exhibit nearly the complete form of the shells of this genus. The particular figure of this fossil had been, by most of its observers, attributed to some changes which it had undergone whilst in a soft mineralized state; but I had been always satisfied of its existing in its original shape, from reflecting on the improbability of its spiral turns having been unfolded without fracture: a circumstance, indeed, which an examination of the specimen renders at once evident. This curious fossil, which is formed of a blueish clay, was found, as appears by a label, which is attached to it, in Shotover Hill, near Oxford.

LXXX. *Scaphites.* A fossil concamerated shell, commencing with spiral turns; the last of which, after being elongated, is reflected towards the spiral part.

I have ventured to form the present genus for the reception of the very rare and interesting fossil, Plate X. Fig. 10, from Dorsetshire, there being no genus in which it could be placed.

This fossil is in a very excellent state of preservation: the nacre is visible on some parts of it, and in others the foliaceous terminations of the chambers may be discovered. At the termination of the reflected part, the mouth of the shell, a border is formed, by the edge of a regularly rounded groove, with which the shell appears to have been here surrounded.

The very wide difference between its form and that of the shells of the genus *Ammonites*, to which it approaches the nearest, is sufficient, I conceive, to show the propriety of a separation. I acknowledge that I was at first disposed to consider it as a monstrosity; supposing that the animal had by some accident been misdirected in its operations of forming its shell, and had thereby been led to the formation of it in this uncommon shape. A closer examination of the shell, however, set aside this opinion; for I then noticed the tubercles on the sides of the straight part, which did not appear at all in the spiral, and but

faintly in the recurved part. This seemed to manifest that, at different periods of its growth, the animal had undergone such certain changes, in the organization of those parts on which the formation of its shell depended, as fitted them for depositing the shell in this intended peculiar form. It is true, that although the tubercles might not be perceptible in the first whirls, yet as the size of the animal increased, so would the respective parts which formed the shell; and, of course, so would the tubercles also, whether the shell was extended in a spiral or a lengthened form. But under the supposition that this had been the case, and that these were the labours of the animal of the *Cornu ammonis*, which had erroneously, as it were, continued out its shell in this, instead of the spiral form, still the parts of the shell would have continued increasing in size with the animal. But here the reverse takes place; for, after the animal has made its reflected turn, the nodules begin to lessen, and the whole of the shell is formed on a diminished scale; from which we may safely infer, that a change of organization in these parts, appropriate to the different changes of form in the shell took place naturally in the animal, and affords sufficient reason for considering it as forming a genus from that of *Ammonites*.

This is confirmed by the chalk fossil, Plate X. Fig. 11, which, with several others, was found by my friend, Mr. Herbert, in a chalk-pit near Brighton. Although but little of this shell appeared, and no more could be traced into the chalk, I was satisfied, when I first saw it, that it could not belong to the genus *Ammonites;* and, as several were found in the same pit, there was no reason for supposing that its peculiar formation was the result of accident. Comparison with the preceding fossil, which I have since obtained, shows plainly that it is of the same genus, and perhaps of the same species, with it.

LXXXI. *Turrilites.* A spiral, turriculated, multilocular shell, the turns contiguous, and all visible. The chambers divided by sinuous septa, pierced in their disks. The mouth round.

Langius gives the figures of two fragments of two distinct species of this fossil; one of which he describes, *Turbinites striatus striis transversis densioribus et ex parte superiore in tubercula abeuntibus a dextra ad sinistram convolutus major pullus duarum spirarum. Tab.* 32, *Fig.* 6. The other he describes as *Turbinites striatus striis transversis, et in medio in duplicem papillarum seriem divisis a dextra ad sinistram convolutis major pullus unicæ spiræ. Tab.* 32, *Fig.* 7. These fossils, he informs us, were obtained from the mountains in the neighbourhood of Baden, in Switzerland. *Hist. Lap. Fig. &c. p.* 111. Two fossils of this species have also been described by Scheuchzer, in his *Physica Sacra*, one of which seems to be entirely different from those of Langius; but the other appears to resemble that of Fig. 7.

The representations above referred to are mere casts of this shell, the shell itself not having been discovered until of late years. This discovery was made by M. Denis Montfort, who discovered two species in the mountain of St. Catherine, near Rouen. One of these he distinguishes as *Turrilites tuberculata;* the whirls of the spire being set with four rows of tubercles, disposed in quincunx order. This shell appears to have been in such a state of perfection as to allow of its form being made out completely. It is regularly formed in a spire, the whirls of which are projecting and articulated, the foliaceous sutures formed by the edges of the septa being apparent. The opening of the shell is nearly round; the columella flat, without any folds; and the septa perforated, nearly in the centre, by a syphon. The other species has the whirls of the spire beset with short ribs, beneath which are two rows of tubercles, and appears to resemble the fossil figured by Langius, Fig. 6. *Journal de Physique, &c. de Thermidor, An.* 7. A cast of this rare and extraordinary fossil is represented Plate X. Fig. 12, in the superior fractured termination of which may be seen the traces of its foliaceous sutures.

LETTER XII.

NUMMULITES......DISCORBIS.....ROTALITES.....LENTICULINA......LITUOLA SPIROLINA......MILIOLA.....RENULINA......GYROGONITES.

LXXXII. *Nummulites.* A lenticular univalve, with an internal, discoidal, multilocular spire, divided into numerous chambers by transverse imperforated septa, and covered by several plates; the *paries* of each turn being complicated, extended, and united on each side to the other disks.

The extreme obscurity in which the nature of these bodies has been involved, almost to the present day, has occasioned the adoption of numerous vague and even absurd conjectures respecting their origin. By some they have been supposed to be the sports of nature, and by others, seeds, the leaves of trees, and even pieces of money, miraculously converted to stone. A variety of terms have been employed to designate these substances. Thus, they have been named *Helicites*, from their spiral structure; *Phacites*, from their resemblance to a lentil; and *Salicites*, from the supposed resemblance of their sections to the leaf of the willow. Pliny is supposed to refer to this body, under the name of *Daphnias*, when he mentions that Zoroaster employed these substances in the cure of epilepsy. From their substance and external form, they have also been termed *Lentes lapideæ;* and from the appearances displayed by their sections, *Lapides cumini, frumentarii,* &c.

Scheuchzer was the first who concluded that these bodies ought to be ranked among the mineralized remains of animals, which had lived before the flood. Having reached this point, still but little further progress was made, for some time, in the knowledge of the real nature of these

bodies. The various descriptions and delineations of them, under the names of *Lapides circulares*, *numismales*, &c. had given rise to the notion, that each of these referred to bodies of completely distinct species; whilst their want of resemblance to the form of any known recent animal, led to various erroneous conjectures, as to their original mode of existence. Thus deceived, some, among whom was Stobæus, *in Opusculis*, p. 8, placed them among those coralline bodies which were named by the oryctologists of that period *Porpitæ*, naming them *Porpitæ nummulares* and *Fungitæ minimi*, *pediculo destituti.* Bourguet also, misled by similarity of figure, considered them as the opercula of some particular species of shells, and probably of the *Cornu ammonis.* Breyn, in 1732, first showed that they were the mineralized remains of a fossil concamerated shell, which might perhaps be considered as a species of *Nautilus.* This discovery was not, however, supported by evidence sufficiently satisfactory to every one; since Spada, *Catalog. Lapid. Veronensium*, p. 46, in 1739, ventured to offer the opinion, that these bodies ought to be considered as bivalve shells. The opinion of Breyn was however confirmed, in the same year, by the discovery of recent minute shells on the Riminian shores, which were evidently of an analogous structure.

Some have concluded this fossil to have been an internal bone of some animal, similar to that of the *sepia;* and even Lamarck was of opinion, that it was not the shell of an animal. "En effet (he says) je soupçonne que les nummulites ne sont pas des coquilles, mais des polypiers voisins des alveolites." *Systeme des Animaux sans vertebres*, p. 402. But Breyn, Gesner, Bruguiere, and, lastly, Lamarck, have, upon strict examination, concluded that the nummulites is a concamerated shell, corresponding very nearly to that of the *Cornu ammonis.* Bruguiere remarked, with astonishment, the extreme smallness of the first chamber of the shell in which the animal may be supposed to have dwelt: the discovery, then, not having been made, that in *Nautilus* and *Spirula* a considerable part of the animal might overlap and

surround the mouth of the shell: a discovery which cannot fail to throw light on the economy of many of the inhabitants of the minute multilocular shells. Lamarck considering that, agreeable to the discoveries of M. Peron, three fourths of the shell of *Spirula* is covered by the animal, and that there is great reason to suppose that one third of the shell of the *Nautilus* is also thus covered, is of opinion, that the nummulite was completely inclosed in the posterior part of the animal by which it was formed; and that a part of the extremity of the animal was contained in, and was adherent to, the last chamber.

Possessing several small masses of these bodies, and having been careful in collecting all the different surfaces and forms under which these bodies presented themselves, in different specimens, I made a careful examination of them, with the hope of obtaining some more particular information respecting their original nature.

The size of the specimens, which I possess, vary in their diameter, from less than an eighth of an inch to an inch and a quarter; and I am satisfied, that I once had some which were full an inch and a half in diameter. In thickness, they vary from an eighth of an inch to half an inch.

Their figure is in general lenticular. Considerable variations, however, are frequently observable in this respect; the lens, from what has been stated in the preceding paragraph, being much deeper in some than in others: some, indeed, being nearly flat, whilst others are even almost globular. In some, a considerable deviation appears to have taken place from their original figure, from their having become bent in various ways. The surface varies considerably in different specimens; being in some nearly smooth, in others rough and scabrous, with numerous small projecting knobs, or undulating lines. Their colour is also various; some being white, some of different shades of brown and red, and others even of a blueish hue; and the difference of colour is certainly not always dependent entirely on the nature of the matrix in which they have been imbedded. The number

of spiral turns also varies considerably in different specimens, and evidently according to the size and growth of the body. Thus, in those of a quarter of an inch in diameter, the number of whirls is from three to four; and in those of an inch in diameter, the number is not less than two dozen. One of these bodies being split transversely through the spiral, beginning in the centre, and continued to the circumference, is seen on each of the inner faces. These spiral turns are divided into numerous chambers, by transverse, supposed imperforated septa, which are a little obliquely extended towards the centre of each disk, and become gradually lost between the approximated plates. An idea of this part of the structure is given Plate X. Fig. 14. In fact, the external plate of each turn of this spiral is folded in two, its particular chambers being formed in the angle of the fold, which then is extended above and below, covering and uniting itself with the outer sides of the inner plates. The specimen, Plate X. Fig. 15, will point out this curious mode of structure. Little processes may be seen going off from the different fractured edges of the plates in the centre, to form the septa in their correspondent whirls.

The same specimen will illustrate a part of the structure which does not appear to have been yet explained. On the surface of the middle plate of this specimen, small undulating risings are observable: these, by their attachments to the under side of the plate which laid over this, connected the two plates together, leaving a vacant space between the plates, where these risings did not exist. As these seeming irregularly undulating lines approach the circumference of the plate, they assume a greater regularity in their direction, and give off, at equal distances, the septa dividing the chambers which are disposed round the folded edge of the plates.

In another species, Plate X. Fig. 17, this connection between the upper and under side of the plates is formed by numerous small and short columnar projections, the points of attachment of which may be seen on both surfaces.

Considering that the specific differences of these bodies are chiefly to be found in the markings of their surface and their internal structure, I shall pursue my examination of these two circumstances, with a view to the necessary distinction of species; and, since Lamarck divides this genus into the four following species, *N. lævigata*, *N. globularia*, *N. scabra*, *N. complanata*, which he states have been found in the environs of Paris, I shall attend to these circumstances, with reference to the specific distinctions of Lamarck.

N. lævigata. Lenticular, smooth, and convex, on both sides. Plate X. Fig. 13. These, he observes, are found of all sizes, from that of a lentil to that of a twelve-sous piece. With the hope of acquiring some knowledge respecting the economy of this animal, or at least of the structure of its concamerated appendage, I rubbed down several specimens in a perpendicular direction, and gave to the sections as high a polish as I was able. By this operation a fair view was obtained of the concentric parietes of the chambers, with the short perpendicular septa by which they were divided. By this section it was also seen, that the processes connecting the different stories of chambers were placed immediately opposite to each other, forming short straight perpendicular lines between the upper and under surfaces. Plate X. Fig. 16. The facility with which these bodies are separated horizontally, also yielded me several opportunities of observing their internal structure, as represented Plate X. Fig. 14. It is there seen that the septa, placed in the spiral whirls, are disposed at nearly equal distances; but the septa of one whirl maintain no particular order of position with those of the others.

In every mass, almost, which I have seen, of this species, I have been struck with the circumstance of several of these bodies being split horizontally through their centre, so as plainly to shew the spiral turns continued to the very centre, as represented Fig. 14. I have one detached specimen, thus split, and showing the correspondent whirls and septa on each internal face.

N. globularia. This species is smooth and subglobose, and is described by Lamarck as being of the size of a full-grown pea. The specimens which I have, answering to the definition of Lamarck, are so very small, that although I have broken several, to obtain a view of their internal structure, I have not yet completely succeeded. It however appears to resemble that of the preceding species.

N. scabra. This fossil is lenticular, the surface irregularly sprinkled with scattered points.

This nummulite, M. Lamarck observes, is rather more convex on both sides than the smooth nummulite is; but its surface is not smooth, like that of the two preceding species. In some, he observes, the surface is beset with small tubercles, or elevated points; in others, with short projecting lines; and in others, both the points and lines are observable.

I am not able to assert, what I believe to be the case, that all the different species of this genus have their outer surface nearly smooth; but I have sometimes seen nummulites, whose inner plates were scabrous, have a tolerably smooth external surface; and I have repeatedly seen the smooth nummulite, with internal plates marked with linear scabrous projections. The fact, I believe, is, that these different markings are all remains of the processes connecting the plates, and are so many different variations in the mode of partially connecting these plates; perhaps by a substance, which, in a living state, possessed some degree of elasticity, and which would, therefore, allow of some little change in the relative position of these plates.

Struck with the peculiar appearance of the nummulite, Plate X. Fig. 18, it being of an irregular tumid shape, a reddish hue, and a slightly scabrous surface, I rubbed it down, so as to obtain a polished surface, in a longitudinal direction. On examining this surface with a magnifying glass, I was surprised at finding it yielded so very different an appearance from that which was seen in the section of the preceding

species. In this specimen, the horizontal plates are much thicker than in the former species, and are formed of perpendicular fibres, which give to the section the appearance of finely-cut cork. The chambers, formed at the folded ends of each plate, do not appear to have their communication with the spaces between the plates interrupted by septa, as is in the case in Fig. 15, of the preceding species.

In this species there does not therefore appear to be any circumstance to forbid the opinion, that air, or any other fluid, being introduced into any one of the cavities, that which was next to the animal, for instance, might be diffused through the whole; and, assuming this to be the case, we may suppose that the animal had the power of occasionally changing its degree of buoyancy, by an appropriate change in the contents of these cavities.

After destroying numerous specimens, for the purpose of ascertaining the real structure of this fossil, I succeeded in breaking the specimen from Verona, Plate X. Fig. 17, in such a manner as brought a part of its internal spiral wreath into view. The appearance of this gave strong reason for believing, that the communication between the cavities was without any interruption, no septa being discoverable by a lens, nor even with the aid of a double microscope. In this specimen the plates had evidently been connected by short columnar bodies, the points of adherence of which are plainly discoverable.

Assuming an unity of principle in the economy of these animals, and seeing in these specimens no reason to suppose that the communication between the cavities was interrupted, may there not be some reason for supposing that a communication may exist in all the species, although too minute to be discovered?

The wide separation observable along the centre of the specimen, Plate X. Fig. 19, with other similar appearances, in a less degree, in other specimens, induce me to make it a question, whether the animal might, or not, have had the power of approximating, and

of separating these plates, for the purpose of increasing or diminishing its degree of buoyancy. The fibrous structure of the plates, Fig. 18, appears to be rather confirmatory of its possessing this power; since, should these have been muscular fibres, their action would have materially affected the size of these cavities.

N. complanata. This fossil is smooth, round, very broad, and flat, with an undulating margin.

This species is directly known by its extreme thinness, every spiral turn and every septum being perceptible even on the surface. One of this species is represented Plate X. Fig. 27; and Plate X. Fig. 21, represents its longitudinal section. By an examination of this section with a single lens, I could not discover any more than the upper and under plate.

Possessing a very interesting mass of nummulites, and other marine bodies, which was presented by the Abbé Fortis to Mr. Strange, I made it the next subject of my examination. Speaking of the fossils observed whilst tracing the course of the Duare to its mouth, the Abbé says: "Further on the road, in the jurisdiction of Slime, are to be seen, in great quantities, various kinds of flints of different colours, and curious marbly compositions of marine bodies, susceptible of a fine polish. I have some specimens, that deserve a place in any museum whatever. One, in particular, is an aggregate of marble, composed of *lenticulares*, fragments of other fossil marine bodies, and white angular pebbles. Among the small petrified *lenticulares* contained in this marble, some have their concamerations distinguishable on the outside. In looking, with the naked eye, on the superfices of this marble, one discovers a very great variety of sections of the *lenticulares* contained in it; and almost every particle, when examined with a glass, affords something agreeable." *Travels in Dalmatia, by Abbé Alberto Fortis, p.* 294.

Of the flints mentioned by the Abbé, in the former part of this paragraph, I possess one which is of a light yellowish colour, in which the

nummulites are very numerous ; and, from the flint bearing a high polish, they are very beautifully displayed in different sections. But the most interesting specimen is, a rounded nodule, apparently a bowlder, full four inches in diameter, and composed of a dark greyish limestone, thickly beset with different species of this shell, other marine bodies, and small silicious pebbles. The examination of the outside of this nodule soon showed me, that it contained species of this fossil, which I had neither seen nor had read of. This rendering me, of course, anxious to give it as complete an investigation as I was able, I had it slit through the middle, and thus obtained two polished surfaces also for examination.

On now examining the polished surfaces with a lens, I was struck with its composition. A mass of grey limestone contained some few detached angular quartz pebbles, visible to the naked eye, and innumerable quartzose particles, which the polishing had manifested, by giving them a considerable degree of resplendency. Among these were disposed the animal remains, which were exceedingly numerous, and consisted chiefly of the common species of nummulites, displayed in a great variety of sections. Other sections were also seen, which exhibited such differences of structure, as at once determined the animals to have been of different species from any which have been before noticed. Several sections were here shown of *N. complanata;* in which, besides the range of chambers, many exceedingly minute interrupted perpendicular lines were seen between these and the outer plates, showing that numerous plates existed here, as well as in the other species; but that they were in this species of an extraordinary degree of fineness, as shown Plate X. Fig. 21.

Plate X. Fig. 20, is a section of a body, in which a line passes along the centre, being a range perhaps of minute chambers, the spaces on each side of which and the external plates being filled up with interrupted lines, so fine as not to be seen but with a lens of considerable

power. Plate X. Fig. 23, is another section, similar to the last, but having a circular spot in its centre. Plate X. Fig. 24, is another section, differing from the two preceding, in having three darker lines pass through it. The section, Fig. 25, appears to be the same fossil as Fig. 20, but altered in its form, and, I conjecture, during the life of the animal.

This is rendered more likely, from the appearance of the section Fig. 26; in which, although the structure differs, the substance being marked with spots in the place of lines, it agrees in having a line of separation running through the substance, with apparently a central cavity, here a similar change of form seems to have taken place. In the section Fig. 22, the general structure resembles that of Fig. 20, 23, 24, and 25, but differs from them in having a line pass along the middle; with two spots of spathose matter nearly at its termination, marking the previous existence of a cavity along the circumference of the body, and continuous with the central line.

In the specimen Fig. 26, as well as in several other sections with a similar central line, an appearance of alcyonic structure is observable.

How far these different species partook of an alcyonic structure, and how much some of them might possess the power of altering their general form, cannot perhaps be ascertained from the extent of our present observations; but, in every species which I have had the satisfaction of noticing, such a structure evidently exists as must have been well adapted to give the animals to which they belonged, the power of regulating their buoyancy, according to the circumstances under which they were placed. Thus, in the ordinary nummulite, if its substance was unyielding, the admission of air or of water into its chambers would have been sufficient to have produced the effect; or if of a softer substance, allowing of a change of figure, then the diminishing or enlarging the capacity of its chambers, by the approximation or the separation of its sides, might be sufficient to effect the necessary

change of specific gravity. Thus also, in those which have been last described, should they have been of alcyonic structure, the action of the muscular fibres would have occasioned such changes of form as are here noticed, and as would, by enlarging or lessening their central cavity, necessarily affect their buoyancy.

These fossils are found in prodigious quantities, in mountainous masses, in different parts of Hungary, Transylvania, Switzerland, France, and Italy. But perhaps these fossils exist no where in more abundance than in Tuscany; where, according to Targioni Tozzetti, they are to be found, particularly in the mountain of Parlascio, forming strata three yards in thickness, and mixed with all the several minute shells which have been figured by Bianchi, in his work, *De Conchis minus notis, &c. Voyage en Toscane, &c.* Tome II. p. 148.

To my kind correspondent, Mr. J. Holloway, of Portsmouth, I am very much obliged for being enabled to ascertain the existence of these fossils in this island. This gentleman furnished me with several of *N. lævigata*, from Stublington Cliff, between Stokes' Bay and Southampton Water.

Although from the minuteness, as well as the imperfect state of the few specimens of which I possess, I may be unable fully to develope the structure and determine the nature of the fossil now placed before you, Plate X, Fig. 28, it is yet hoped, that sufficient will be shown to render it interesting. An examination, with a powerful lens, was necessary, to discover most of those peculiarities, in the structure of this fossil, which will be noticed in its description.

LXXXIII. *Fasciolites.* A subcylindrical, shelly, or bony body, about half an inch in length, rather tapering at the ends, and formed by the spiral arrangement of the perpendicular, concamerated tubes, the tapering end of each of which is obliquely and transversely folded on that of the preceding one.

The appearance which this fossil offers to the naked eye is shown

Plate X. Fig. 28. It is rather rough and scabrous; partly from the removal of some small portions of its surface, and partly from the adherence of some of its calcareous matrix. On being viewed with a lens, it presents the appearance Plate X. Fig. 30. The tubes are seen to be distinct; and, where the outer surface has been removed, the concamerations are perceived, resulting from the interposition of very numerous and minute septa, transversely disposed. These tubes narrow as they approach to their terminations, and as may be seen in Fig. 29, which represents one of the ends of the fossil magnified, the end of each tube overlaps that of the preceding. That this is the case, and that these tubes are placed perpendicularly round the centre, is evident, from the appearance of the longitudinal section, Fig. 31, in which a section is seen of the central and surrounding tubes, divided into compartments by their small and numerous septa.

From this examination it appears, that round the small first-formed tube, or chamber, successive increasing columnar tubes were disposed folding over each other at their ends. Whether these several tubes were, as it is most probable, internally connected with each other, or not, or whether the chambers communicated, or not, with each other, by a siphuncle; are questions, which must remain to be answered by the examination of some more illustrative specimen. Like some of the nummulites, this body, when polished, has more the appearance of bone than of shell. From this circumstance, as well as from the number and appearance of its septa, I am disposed to consider this body as approximating nearer to the nummulite than to any other fossil.

LXXXIV. *Discorbis.* A spiral discoidal univalve; the turns all contiguous, uncovered, and perceptible. The septa transverse, whole, and frequent.

Lamarck, who has seen these shells only fossil, supposes them to be known only in that state, and wishes that circumstance to be pointed out by the termination of the name of the genus, *Discorbites*. It is said

to have been found fossil about Senam, in Etruria. Mr. Montague discovered this fossil among the Sienna minute fossils also.

The same gentleman has also received it, in a recent state, from the shores of Kent and Devonshire; and he has found some specimens of *Sertularia abietina*, taken in the deep by trawling, covered with them. In the Linnean Transactions, and by Mr. Fichtel, these shells have been considered as nautili; but Mr. Montague observes, that, "notwithstanding such respectable authority, he cannot assent to that opinion. No *Nautilus* is ever sessile; whereas this is never detached but by accident, and then the animal dies. Besides, nothing can be more irregular in structure, and the Linnæan characters of the *Serpula* admit of its being chambered." *Supp. to Test. Brit.* p. 160.

It is necessary to observe, that a very close agreement will be found, on comparison of the figure given by Lamarck of *D. vesicularis*, which I have copied Plate XI. Fig. 1, with *Nautilus inflatus*, Plate 18, Fig. 3. of *Testacea Britannica;* the latter being a non-descript species of *Nautilus*, found by Mr. Montague among sand on the coast of Devon.

LXXXV. *Rotalites.* A convex, conical, spiral, multilocular univalve, slightly radiated beneath; the opening marginal, trigonal, and rather turning downwards.

Lamarck divides this genus into four species: *R. trochidiformis*, *R. lenticulina*, *eadem sinistrorsa*, *R. depressa*, and *R. discorbula:* all of which are found at Grignon; and none exist, he believes, but in a fossil state. Plate XI. Fig. 2, represents the lower radiated surface of *R. trochidiformis;* the upper surface being spiral, and rather conical. Plate XI. Fig. 3, represents the upper surface of *R. discorbula;* the form of which shell, together with the circumstance of the mouth of this genus turning downwards, out of the line of the preceding whirl, and the frequent occurrence of heterostrophes, would make them approximate to *Nautilus beccarii*, but that no mention is made of their possessing any siphuncle.

LXXXVI. *Lenticulina.* A sublenticular, multilocular, spiral univalve; the external margin of the turns being complicated, the septa reaching to the centre on each side: the septa entire, curved, and standing out, on the upper and under surface, like rays. The aperture narrow, and projecting beyond the penultimate turn.

These shells are distinguished by Lamarck from those of *Nautilus* by their having no syphon; and from those of *Discorbis* and *Rotalites*, by the septa reaching to the centre on each side. He states, that the recent shell has been found in the sea, near Teneriffe, at the depth of a hundred and twenty-five feet. Three species are found fossil in the environs of Paris: *L. planulata*, *L. variolaria*, and *L. rotulata.* The last of these I have represented from Lamarck, Plate XI. Fig. 4, being entirely unacquainted with this genus.

LXXXVII. *Lituola.* A multilocular univalve, partly spiral, the last turn being straight at the end: the chambers irregular: plain transverse septa, the last having several openings.

The chambers of this shell appear to be very irregularly disposed, and the orifices in the last septum are generally from three to six; but the other septa do not appear to be pierced by any siphunculus.

Lamarck describes two species, both fossil, not knowing of their existence in a recent state. Plate XI. Fig. 5, is a representation of *Lituolites nautiloidea.* Fig. 6, is *L. difformis;* and Fig. 7, is the same shell, rubbed down, to show the internal structure.

I have suspected the former of these shells to be, perhaps, *N. semi-lituus*, or *subarcuatulus*, and the latter to be *N. carinatulus*, Fig. 73, of Walker; but there is no agreement in the openings.

LXXXVIII. *Spirolina.* A multilocular univalve, in part spirally convoluted: the turns contiguous, the latter ones straight: the septa transverse, perforated by a tube.

These minute shells are so alike in their general form to those of the genus *Spirula*, that Lamarck, who has discovered several species and

varieties of them at Grignon, was much disposed to place them under the same genus, until he adverted to the circumstance of the spiral turns in these shells being contiguous, whilst in *Spirula* they are separate.

They in general form one or two spiral turns in a horizontal direction, and then become elongated in a straight line. In some species there is only a little curvature, instead of the spiral turns; and, in others, the whole shell is entirely straight. Some have their spiral turns flattened, others have them cylindrical; but the chambers in all form some degree of projection externally which gives the shell the appearance of being divided by transverse ridges. May not the straight species be the *Nautilus radicula* of Montague? Plate XI. Fig. 8 and 9, represent the different species particularized by Lamarck; *S. depressa* and *S. cylindracea*, Fig. 10, being supposed to be a variety of *S. cylindracea*, Fig. 9.

LXXXIX. *Miliola.* A transverse, ovato-globose or elongated, multilocular univalve, with transverse chambers, involving the axis alternately, and in three directions: the opening small and circular, or oblong, at the base of the last chamber.

The frequency of these fossils, in the neighbourhood of Paris, is such, that some species of them form the principal part of the masses of stone in some of the quarries. Lamarck describes seven species: and gives figures of five of these species, which are here copied. These figures are considerably magnified, the actual size being about that of a grain of sand. Plate XI. Fig. 11, is *Miliolites ringens;* Fig. 12 and 13, are of *M. Saxorum;* Fig. 14, 15, and 16, of *M. cor anguinum;* Fig. 17, 18, and 19, of *M. trigonula;* and Fig. 20, of *M. opposita.* The other species mentioned by him are, *M. planulata* and *M. birostris.*

It is also mentioned by this author, that he possesses recent specimens of these animals, which were taken on *fucus*, near the Island of Corsica. Agreeable to this account of Lamarck's, of these animals having been found in a recent state, are the discoveries of the late Mr. Boys and of

Mr. Walker, who found on our shores, in a recent state, three, and perhaps four, of the species which have been just shown to exist, as fossils, in the neighbourhood of Paris.

Miliolites Saxorum, Lam. appears to agree with the hollow oval worm-shell, *Serpula subovalis intorta*, of Mr. Walker, *Testac. minut. rarior.* Pl. I. Fig. 1. Mr. Montague, who separated from the genus *Serpula* those shells of this family which are independent, or not attached to other bodies, and placed them under a new genus, which he names *Vermiculum*, considers this shell as *V. intortum;* and very justly observes, agreeable to the observations which I have myself made on the fossil shells in the sand from the neighbourhood of Paris, that it is so variable in its formation, that, without great attention, it might be formed into several species. *Testac. Brit. p.* 521.

Miliolites opposita, Lam. Plate XI. Fig. 20, is undoubtedly the same shell as the bellied semilunar worm-shell, *Serpula bicornis ventricosa* of Walker, *Testac. min. rar.* Pl. I. Fig. 2. The difference which exists between the representations of Lamarck and Walker, is very satisfactorily explained by the observations of Mr. Montague, who, previously to the same shell having been figured as a fossil, suggested such alterations in the figure given by Mr. Walker, as would make it agree perfectly with that of Lamarck, and names it *Vermiculum bicorne*, *Testac. Brit.* p. 519. *Serpula bicornis umbilico perforato*, *Testac. min. rar.* Plate I. Fig. 3, appears, in Mr. Montague's opinion, to be no other than a mutilated specimen of the former shell. The recent shell was found at Sandwich and Reculver.

Miliolites cor anguinum, Lam. Plate XI. Fig. 14, 15, and 16, exactly corresponds with *Serpula subrotunda dorso elevato*, of Walker, *Test. min. rar.* Plate I. Fig. 4, *Vermiculum subrotundum*, of Montague.

M. trigonula, the different sides of which are shown Plate XI. Fig. 17, 18, and 19, is an inflated body, of an ovato-trigonal form: its recent analogue does not appear to be known.

XC. *Renulina.* A flat, sulcated, reniform, many-chambered shell:

with linear chambers, adapted to the curves of the shells; the last being longest. The axis marginal.

The fossil which is represented from Lamarck, *Renulinites opercularia,* Plate X. Fig. 21, is the only species of this genus with which he appears to have been acquainted, and is about six lines in length.

Whilst viewing this shell, he remarks, we might conceive that it was a very thin, fragile, flat, semilunar operculum, with the surface covered with parallel bowed grooves; but, on examination, it will be found that it is composed of two plates, placed close against each other, with their inner surfaces hollowed out in contiguous bowed grooves, which, as the plates are applied to each other, form distinct chambers. This, it is justly observed, is not the kind of structure, observable in any operculum whatever.

Notwithstanding the different appearances exhibited by Lamarck's figures of *M. opposita,* Plate XI. Fig. 20, and the figure of *Renulinites,* I am very much disposed to believe them to be of the same genus, if not the same species. This notion I have been led to, by observing the figure of Walker's bellied semilunar worm-shell, which indeed seems to unite the two figures of Lamarck, by possessing the general form of *M. opposita,* and the contiguous bowed grooves of *Renulinites.* To illustrate what I have here said, I have introduced Walker's figure, at Plate XI. Fig. 22.

XCI. *Gyrogonites.* A sphæroidal hollow shell, composed of linear curved pieces, slightly grooved at the sides, where they are joined; by the joining of which grooves, linear chambers, following the direction of the pieces, appear to be formed. At these joinings, on the external surface, are carinated ribs, disposed transversely about the middle, and spirally at each pole of the shell. At one of the poles there is sometimes to be seen a circular opening, which sometimes appears to be closed by a particular valve or operculum.

This shell is represented magnified, Plate XI. Fig. 23, its natural size being that of a small pin's head. It is found in silicious stones,

not possessing transparency, at Montmorency, Erappes, &c. Lamarck observes, that it has the form of a very small seed of some species of lucern; and, hesitating at determining it to be really a multilocular shell, only assumes it as such for the present. At Fig. 24 is represented one of its detached carinated ribs.

LETTER XIII.

BIVALVES WITH EQUAL VALVES, AND REGULARLY FORMED.....PINNA ......MYTILUS.....MODIOLA......ANODONTA.....UNIO......NUCULA.......PECTUNCULUS......ARCA.......CUCULLŒA.......TRIGONIA.......TRIDACNA....... HIPPOPUS......CARDITA......ISOCARDIA......CARDIUM.......CRASSATELLA .....PAPHIA......LUTRARIA......MACTRA......ERYCINA......PETRICOLA...... DONAX.....TRIGONELLITES.....VENUS.....CYTHEREA......VENERICARDIA CYCLAS.....LUCINA.....TELLINA....CAPSA.....SOLEN.....SANGUINOLARIA .....GLYCEMERIS.....MYA.....PANOPEA.

We now proceed to the examination of the fossil remains of bivalve shells, the dwellings of acephalous molluscæ, having no distinct head, and therefore unprovided with eyes, ears, &c.

Bivalves, with equal valves.

XCII. *Pinna.* A cuneiform, longitudinal bivalve, with an acute base, gaping in the upper part: the hinge without a tooth, lateral, and very long: the valves coalescent.

One species only, *P. margaritacea*, Lam. is found in fragments, at Grignon. Specimens which may be referred, perhaps, to the same species, are found in the cliffs in the neighbourhood of Bognor: these

are casts of stone, and sometimes bear the complete form of the shell, although the internal margaritaceous part alone is remaining. Mr. Martin found specimens which he at first thought were ***P. nobilis*** in the neighbourhood of Buxton, but he was afterwards satisfied that it was some unknown species. One of these is represented in Plate VI. of his interesting work on Derbyshire petrifactions.

Plate XI. Fig. 31, is a magnified representation of a minute fossil pinna, resembling ***Pinna saccata***, which I lately discovered in sand from Grignon.

It is observed by Bosc, that the texture of the ***Pinna*** is different from that of any other shell. Instead of possessing any thing of the laminated structure, the shell of the ***Pinna*** seems to be formed by the juxta position of calcareous molecules—perhaps by a species of crystallization. The fracture of these shells, when viewed by a lens, shows exceedingly fine striæ, perpendicular to the surface of the shell. This structure, he is of opinion, is sufficient to distinguish this shell, even in ever such small fragments, and in a fossil state. ***Histoire naturelle des Coquilles, Tome*** III. p. 123.

This, however, is not strictly the case; since fragments of other shells, of a similar structure, are frequently found, especially in chalk. Such are, *Trichites pactilis undulatus cretaceus*, and *Trichites pactilis cretaceus, lamellatus*, of Lhwydd, ***Lith. Brit. Ichnogr.*** Nos. 1751 and 1752, which are the remains of the remarkable shell, of which I have already spoken, under the genus *Patella*, Letter vi. page 51, of this volume. A similar structure I shall also have to notice, in a fossil oyster. This astonishing serection by an animal, of calcareous spar, in a crystallized form, appears to be a circumstance highly deserving the attention of the physiologist, as well as of the admirer of crystallography.

The pinnite is rather a rare fossil. It is however sometimes found, with the Oolites, in the lime-stone of the northern parts of Wiltshire, in Somersetshire, and in the lime-stone of Gloucestershire. I have two of these specimens; but sufficient of the shell is not visible, to

allow of an opinion being formed as to their specific characters; excepting that neither of them seem to accord with any of the species particularized by Linnæus. The remains of a shell belonging to this genus is sometimes found among the Devonshire Blackdown fossils.

XCIII. *Mytilus.* A longitudinal bivalve, with an acute base; the beaks straight, subacute, and terminal; the hinge, in most, without a tooth: only one muscular impression.

Bruguiere separated from this genus the *aviculæ* and *anodontæ*, with such oysters as Linnæus had included in it; and Lamarck has rendered the genus more precisely determined, by abstracting from it also the shells with which he forms his genus *Modiola.*

Lamarck describes two species of fossil muscles, *M. rimosus* and *M. denticulatus*, found at Grignon and Long-Jumeau. Dr. Woodward mentions several shells of this genus found in different parts of England, *Catalogue, Part* II. p. 62.

I do not know that I can introduce the following extraordinary fossil, Plate XI. Fig. 32, in a more appropriate place than under the genus *Mytilus*, agreeable to the label attached to it, which thus describes it: *Muscolo petrefatto rappresentante una foglia e di ughezzano nel Veronese non pi ancora descritto e figurato da alcun litologo.* I have however met, in *Catalogi lapidum Veronensium mantissa* with two figures of this fossil, and the following remarks on it:—"Abunde hi lapides occurunt in Valle vulgò *d'Anguilla* agri Veronensis, qui etsi aspecto suo, folia demonstrare videantur, nihilominus minime ad folia; sed potius ad tegumentum cujusdam piscis armati eos pertinere puto, quam tamen opinionem aliorum judicio permitto. Egre e multitudine horum lapidum, quadraginta bene impressos sejunxi, nam ceteri, qui nuncusque inventi fuere, nullius momenti sunt." *P.* 11.—The great number of these bodies existing in one part, affords a strong argument against either their figures, or their markings, having depended on any accidental circumstance: and their spathose substance, as well as their thickness, determine them

not to have been of vegetable origin. There is, I think, very little reason for doubting its being a bivalve shell; and its general form induces me to place it under this genus. I obtained it at the sale of Mr. Strange's collection; and am disposed to consider it as remarkably interesting, from the singular markings which it bears.

XCIV. *Modiola.* A subtransverse inequilateral bivalve; the posterior side being much the shortest, and the beaks lying towards the shorter side: the hinge without a tooth, having only a marginal, linear, cartilaginal groove: only one muscular impression.

This genus is exemplified in *Mytilus modiolus*, Linn. The modiolæ are separated by Lamarck, from the mytili, on account of their width allowing them to be considered as transverse shells, of their beaks not terminating the shell, and of their not attaching themselves by a byssus, as the muscles do. He figures five species, as found in the environs of Paris: *M. subcarinata, M. sulcata, M. pectinata, M. arcuata*, and *M. cordata.*

Dr. Woodward describes specimens of this genus, as found in Gloucestershire, *Catal.* p. II. p. 62, No. 660, &c. whence I have obtained *M. subcarinata.*

XCV. *Anodonta.* A transverse shell, having three muscular impressions: the hinge plain, without any tooth.

Mytilus anatinus is of this genus; but I know of no fossil shell which can be referred hither.

XCVI. *Unio.* A transverse shell, having three muscular impressions: an irregular callous hinge-tooth, prolonging itself on one side beneath the ligamental slope, and articulating with that of the opposite valve.

This is a river shell, which does not appear to be known fossil.

XCVII. *Nucula.* An inequilateral, equivalved, subtrigonal bivalve: the hinge on a line, bent at an angle formed by numerous, alternately inserted teeth; the beaks approximating, and turned backwards.

Lamarck divides the *Arcæ* of Linnæus into three genera: *Arca*, having

the hinge on a straight line; ***Pectunculus***, having the hinge arched; and *Nucula*, having the hinge on a line bent at an angle. The shells of this genus are marine shells.

Nucula margaritacea, Lam. *Arca nucleus*, Linn. are found at Grignon, Courtagnon, &c. I have also found shells of this species, with their fine comb-like teeth, and their pearly coat, quite perfect, in the Essex bank of shells; and in a perfect state, and of a microscopic size, at Plumsted. I have also disengaged one or two minute calcedonic specimens of this delicate shell, in a perfect state, from the Devonshire whetstone.

Lamarck describes two more species of this genus among the Parisian fossils; *N. striata* and *N. deltoidea.* In a minute fossil-shell of this last species, not larger than a small pin's head, which I found in a *Cerithium gigas*, the original margaritaceous lustre still exists; and in one of the former, of the same size, the striæ are very evident.

XCVIII. ***Pectunculus.*** An orbicular, subequilateral bivalve, with an arched hinge; with numerous teeth, alternately inserted in a single row.

Lamarck enumerates five species:

P. angusticostatus. *P. terebratularis.* *P. nuculatus.*
P. pulvinatus. *P. granulatus.*

The shells of this genus are easily known by their rounded or lenticular form. Their teeth are larger, and less closely set, than those of the arks, and disposed in an arched line, which becomes very narrow, or is even interrupted, under the beaks. The muscular impressions are two, and strongly marked; each forming a callous projection, the edge of which is sharp.

In the Essex bank, numerous shells of this genus are found, which seem exactly to agree in character with *P. glycemeris*, Lam. *Arca glycemeris*, Linn. The species of this genus are, from their general agreement, difficult to separate; but I believe that the skilful conchologist would be able to make further divisions of these Essex shells. Shells of this genus, and chiefly, I believe, *P. angusticostatus*, Lam. are frequent in the Bognor rocks.

In the whetstone sand-pits, at Blackdown, a small species of this genus is found, in which the shell is very thick, and the teeth of the hinge few and large. These pectunculi, with several of which I have been favoured by the Rev. Mr. Cleeve and Mr. Clarke, are so much impregnated with silex, that some of them possess a considerable degree of transparency.

XCIX. *Arca.* A transverse inequilateral shell: the beaks distant; the hinge with many teeth, disposed in a straight line; the teeth lamellated, close, and alternately inserted between each other: a subrhomboidal smooth area between the beaks, on which the cartilage was disposed.

These are marine shells; and are easily recognised by their general form. They frequently gape along their superior edge, and have two marks of attachment on each valve. Lamarck particularizes seven species, which are found fossil in the neighbourhood of Paris:

A. diluvii.	*A. barbatula.*	*A. interrupta.*	*A quadrilatera.*
A. biangula.	*A. angusta.*	*A. scapulina.*	

Shells of this genus are frequently found fossil in this island. One cast from Bath seems to be of *A. noæ.*

At Plate XI. Fig. 29, is represented an ark of an uncommon form, the valves terminating in an alated form. This is a German fossil, and is attached to some oysters, with serrated margins: a sufficient portion is, however, visible, to allow of the drawing to have been fairly taken, although not sufficient to allow of particularizing its specific characters.

C. *Cucullæa.* A nearly transverse, inequilateral, ventricose bivalve, with distant beaks: the hinge formed of many teeth, disposed in a right line, and terminated at each end by three or four transverse parallel teeth: a flat and sulcated area, for the reception of the cartilage.

The shells of this genus differ from the arks, in the teeth at the end of the hinge, which are placed in a transverse direction, directly contrary to that in which the row of small lamelliform teeth are disposed. *Arca cucullata* of Chemnitz, *Tom.* VII. *Tab.* 53, *Fig.* 526—528.

The largest shell of this genus is *Cucullæa crassatina ;* a ventricose shell, of considerable thickness, three inches and a half in length, and four in width ; the external surface smooth, except from fine transverse striæ, marking the growth of the shell, and faint traces of longitudinal sulci. This shell is found in the neighbourhood of Beauvais, and is the only species mentioned by M. Lamarck.

Among the beautiful fossils yielded by the Devonshire whetstone-pits, is a shell belonging to this genus, with specimens of which I have been kindly favoured by Mr. Cleeve. This shell, which, if it has not been already otherwise designated, may be named *C. glabra*, is a thick, oblong, transverse shell, nearly smooth, being marked only by the fine transverse striæ formed by its growth. The beaks are separated by a large flat rhomboidal area, with markings, which, when the valves are united, assume a lozenge form. The line of the hinge is finely crenulated, as well as the three transverse teeth, which terminate the hinge at each end. Mr. Francis Crow, who, as has been mentioned, found, in a field at Faversham, a silicious specimen of *Strombus pes pelicani*, exactly agreeing with that which I had been favoured with from the Devonshire whetstone-pits, found, in the same spot, several silicious shells of this genus also. This coincidence deserves particular notice, since it points out a singular agreement in the strata. The shell of this genus found by Mr. Crow, though not unlike that of Devonshire in its general form, is specifically different. This shell, if not already named, might be designated as *C. decussata*. It is a thick oblong transverse shell, with flattish longitudinal ridges, decussated by fine transverse striæ. The area separating the beaks, large, with slightly undulating markings in the form of half a lozenge. The long line, as well as the transverse teeth of the hinge, which in the preceding species were crenulated, appear, in this, to have been smooth. Among the shells which I was favoured with by Mr. Crow, is a single valve, which, from its extraordinary thickness and great obliquity, I am disposed to consider as of different species from either of the preceding : it is, however, in a state which will not

allow of this being determined. A representation of the inside of this shell is given Plate XIII. Fig. 1.

CI. *Trigonia.* A trigonal or suborbicular inequilateral bivalve. On the right valve are two oblong, flat, diverging hinge teeth, transversely grooved on each side: on the left valve, four flat hinge teeth, transversely grooved on one side only, disposed in pairs, each pair diverging and exactly receiving those of the opposite valve.

These shells have been long known and admired in their fossil state, both in this island and on the continent. The first notice that I find of them is that of Langius, who gives a figure of one of these shells, *Hist. lap. fig. Helv. Tab.* 44, *Fig.* 5, and speaks of it as *Conchites Helveticus visu prodigiosus, triqueterus striatus,* and thinks it resembles *Concha indica visu prodigiosa,* Bonanni, No. 91.

Our English naturalists very early noticed this curious fossil. Dr. Plot gives to a cast of this genus the name of *Hippocephaloides, Hist. of Oxfordshire, Plate* VII. *Fig.* 1.; and Lhwydd, who gives to these shells the name of *Curvirostræ,* mentions several; such as, *C. rugosa clavellata major,* from Garsington; *rugosa minor, clavis aut nullis, aut paucissimis ægre conspicuis donata,* from Buckinghamshire; *rugosa major non clavata, seu levibus rugis exsculpta,* from Bullington, *Lithol. No.* 700, &c. From these notices of Lhwydd it appears, that, at least, three species of this genus were known to him to have existed in this island. Da Costa speaks only of these shells, to express his doubts, whether to place them under *Cunei* or *Arcæ,* no knowledge having then been obtained as to the kind of hinge which they possessed.

M. Walch, who was very much at a loss in what genus to dispose of them, was disposed to place them among the *Veneres impuberes* of Linnæus. Of these shells, he saw three species: complete shells of *T. clavellata* and *T. costata,* and a fragment of *T. aliformis;* but, being unacquainted with the hinge, he does not appear to have been fully aware of their relationship. Speaking of the latter of these fossils, he makes the following remarks on the curious circumstance of the characters of

shells, of different genera, being combined in this one shell:—" Une espece de coquilles des plus rares dans le regne des fossiles, qu'on ne sait encore sous quel genre elle pourroit etre convenablement rangée, vu qu'elle tient en mème tems, beaucoup du musculite, de l'arche et de la conque de Venus. Elle approche fort du musculite par le raport de sa longueur à la largeur; elle ressemble à un arche, par une petite eminence, ou une espéce de petite plate forme qui se trouve entre les deux bords de la charnière: et les bords, qu'elle a un peu convexes d'un coté, lui donne la ressemblance avec la conque de Venus." *Monumens des Catast. Tome* II. *p.* 66.

Notwithstanding the combination of the characters of the muscle, ark, and Venus, as observed by Walch, and to which may be added those of the cockle and the tellen, these shells vary so much from every other, as to render their description difficult. On first view, the shell appears reversed: the anterior end, on which, particularly in the Venuses, the area surrounding the cartilaginal depression is disposed, and which is in general flat, as if it were truncated, is, in these shells, considerably extended out; whilst the beaks of the shell are turned towards the anterior side, leaving the posterior side with no cordiform impression, but having all the appearance of the anterior side, in the shells of the Venus kind.

Bruguiere has, I understand, described, in *l'Encyclopedie Methodique*, four species of this genus; but, being unable to obtain this work, I am uninformed with which of the species he is acquainted.

The first information which I gained respecting the generic character of these shells, was from a fossil purchased from Mr. Strange's collection; in which the left had so slipped from the right valve, as very fully to display the structure of the hinge. Bruguiere having been so fortunate, as, by clearing a valve, to discover the kind of hinge which it possessed, found it necessary to form a genus for the reception of these shells, and named it *Trigonia*, from the form which generally belonged to the species then known.

But, as in my specimen, so in Bruguiere's, it was the hinge part of

the right valve which was shown, from which, alone, the real nature of the hinge could not be determined. This information was, however, obtained by the discovery, by M. Peron, of a complete recent shell of this genus, on the coast of New Holland, on Capt. King's Island. Some separate valves of the same shell, a little injured by the air and by friction, have also been picked up at Maria's Island, and at the island of Kangaroos.*

Trigonia Margaritacea is the name given by Lamarck to this recent shell. It is somewhat of an orbicular form; appearing, when the valves are closed, not unlike a cardium, with hardly any cartilaginal area. Twenty-two longitudinal ribs, crenulated through their whole length by crescent-formed and granular tubercles, diverge from the hinge to the margin. The internal surface of the shell is covered with a brilliant, silverish, and slightly iridiscent nacre. The muscular impressions are two, and are placed laterally, near to the teeth of the hinge.

In this specimen, the real nature of the hinge was ascertained. On the right valve are two flat teeth, which are rather thick, and transversely grooved on each side; and on the left valve are four, or rather two, double teeth, which, as well as those in the left valve, diverge from each other in their upper part. These teeth are only grooved on their inner side, in the cavity formed by each double tooth: this cavity, and the small transverse grooves, being fitted to receive the teeth of the opposite valve, and to correspond with their alternate ridges and grooves. A view of the hinge of this shell is given Plate XII. Fig. 1, showing the structure of the part of the hinge belonging to the right valve; and Fig. 2, the corresponding part of the hinge belonging to the left valve.

At about the time when this discovery was made, Dr. Menish, who had obtained some of these shells, as well as some masses of the Blackdown sandstone, containing shells, from his friend Mr. Clarke, of Bridwell, was so fortunate as to remove the matrix from the inside of the

* Ann. du Mus. Tome IV. p. 351.

left valve, and to find the two doubled teeth, so disposed and so grooved, as exactly to receive the teeth of the opposite valve: he was also enabled, by the same aid, to extend the number of species. Having, through the kindness of Captain Gardiner, been favoured with many of the Doctor's specimens, and having been also kindly assisted by Mr. Clarke and the Rev. Mr. Cleeve, I am able to place before you nine species:

T. clavellata.	*T. aliformis.*	*E. sinuata.*
T. costata.	*T. dædalea.*	*T. rugosa.*
T. eccentrica.	*T. spinosa.*	*S. rudis.*

*T. clavellata, curvirostra rugosa clavellata major.** Luid. A trigonal shell beset with nodular projections, disposed on the disk of the valves in rows, in a transverse curved direction: on the anterior side, a sloping, slightly rugose surface, widening from the beaks to the anterior point of the valves, and ornamented with three crenulated ridges; the innermost of which enclose a long oval area, faintly marked with longitudinal striæ, and reaching from the beaks nearly to the anterior termination of the shell. Beneath the beaks is a small sulcus, apparently for the reception of the cartilage. Plate XII. Fig. 3.

T. costata. A trigonal shell, with frequent rounded transverse ribs, passing from the posterior margin to a crenulated ridge, which separates the disk of the valves from the anterior or inferior sloping surface, on which are, longitudinally disposed, three crenulated ridges, with six smaller interposed; the inner, of the larger crenulated ridges, enclosing a flat long oval area, in the upper part of which is the depression for the cartilage. Plate XII. Fig. 4.

The preceding species have been long known on the Continent. The person who first found them being a collector, contrived, by exchanging them, to obtain a handsome collection of fossils.

T. eccentrica. A transverse ovate-oblong shell, with transverse, obtuse, rugose ribs, eccentrically disposed, and obliquely intersected by the lines which mark the growth of the shell. Plate XII. Fig. 5. Spe-

* Curvirostra a Cardine (si in plano posueris) dextrorsum vel sinistrorsum reflexo, nomen obtinuit.

cimens of this shell I was favoured with by the Rev. Mr. Cleeve, and by Mr. Clarke.

T. aliformis. A wing-shaped ribbed shell. The first ribs, which commence at the beaks of the shell, are transverse, but acquire a slanting direction as they fill up the posterior part of the disk, until those which terminate in the superior margin, become longitudinal, and are thus continued to the anterior termination of the shell. The ribs of the posterior side augment in size as they proceed to the margin; but those which are disposed on the anterior side, are of the same size through their whole length. On the inferior, or rather anterior side, is a wide excavated area, on each side of the cartilaginal depression and the margin of the shell, on which transverse ribs are disposed. Plate XII. Fig. 9. This specimen, which was in Dr. Menish's collection, I was presented with by Captain Gardiner.

T. dædalea. Of this shell I only possess the fragment Plate XII. Fig. 6, from which it is impossible to speak of the form of the shell. The anterior side and cartilaginal area appear to have been very wide. The disk is ornamented with granular and nodular projections, disposed in dædalean windings, so pecular in their dispositions, as to allow the assuming of this as a specific distinction.

T. spinosa. A suborbicular shell, the whole of the disk covered with ribs formed of spinous tubercles. The ribs curved, commencing at the beaks in a transverse direction, passing over the middle of the disk in an oblique, and at the superior margin, approaching to a longitudinal direction. The area on the anterior side of the shell is also covered with curved transverse ribs, formed of small tubercles. Plate XII. Fig. 7. This specimen I was favoured with by Captain Gardiner, from Dr. Menish's collection.

It is true, that in this specimen the appearance of the projections is more that of tubercles than of spines; but, on inspection with a lens, I find that most of these are broken; and, on examining another specimen, a part of a valve of indubitably the same species, I discover that at

least, towards the superior margin, these projections are carried out as spines, to a considerable length, and in a rather curved direction, as may be seen in the very slightly magnified view of them, Pl. XII. Fig. 8.

T. sinuata. This is the smallest known shell of this genus. It is a transverse, oblong, ovate, subventricose shell, with transverse winding ribs, making an obtuse angle, and changing their direction both at the anterior and posterior sides of the shell. Plate XII. Fig. 13. I am indebted to Mr. Clarke for specimens of this species.

T. rudis. The form of this species is oblong, approaching to the circular: the cartilage slope is very indistinct: the shell, in its general external appearance, very much resembles an oyster; it having a good deal of that rudeness of surface which oysters in general possess. It is also beset with round nodules, like those of *T. clavellata;* but, in this species, these nodules are very irregularly disposed. Plate XII. Fig. 10, shows the character of the shell; the dotted outline, obtained by the kindness of Mr. Clarke, from a fine specimen in his possession, giving the form.

The preceding five shells are found in the whetstone-pits of Devonshire, are completely silicious, and possess different degrees of transparency.

T. rugosa. Of the form of this shell I cannot speak decidedly, since a fragment of it only remains. This is imbedded in a grey lime-stone, but I am ignorant where it was found. The whole of its disk appears to have been covered with transverse rugous ribs. Pl. XII. Fig. 11.

Shells of this genus have abounded in the Portland free-stone: the shells are, indeed, now decomposed and gone, but a prodigious number of their lime-stone casts are found in these quarries. At Tilsbury, in Wiltshire, are sometimes found calcedonic casts of this shell. One which I possess, and with which I was favoured by that highly respectable gentleman, Mr. Cunnington, of Heytesbury, is rendered very interesting, by numerous included minute bivalves being discovered in the transparent calcedony. The casts of these shells having been

so long known as fossils, under the name *hypocephaloides*, a representation of the calcedonic cast, from Tilsbury, is given Pl. XII. Fig. 12.

One circumstance respecting the shells of this genus demands particular mention. Lamarck has figured, in the recent shell *T. margaritacea* two marks of attachment, one at the bottom of each tooth of the hinge; but I have not been able, in any of the fossil shells which I possess, to discover more than one mark of attachment, which is on one side; a considerable cavity behind the hinge-tooth, on the other side, at *a*, Fig. 1 and 2, seems to be well calculated to receive a part of the animal, which might be attached to the posterior part of this cavity.

CII. *Tridacna.* A subtransverse inequilateral shell: the hinge formed of two compressed and entering teeth; the crescent, or posterior depression, gaping.

The shell, to which this genus is appropriated, is, *Tridacna gigas*, Brug. or *Chama gigas*, Linn.

Fossil shells of this genus are, I believe, very rare. They have been said to exist in the neighbourhood of Verona, and of a very considerable size; but I have not known of the existence of such fossils in any Museum. I have one, which is very small, from Mr. Strange's collection. A similar shell is figured by Wolfart, *Hist. Nat. Hass. inf.* Tab. x. Fig. 1, 2.

CIII. *Hippopus.* A subtransverse inequilateral shell: the hinge formed of two compressed entering teeth; the crescent, or posterior depression, closed.

This genus includes the *Chama hippopus*, Linn. I do not know of any fossil shell of this genus having been found.

CIV. *Cardita.* An inequilateral bivalve. The hinge with two unequal teeth: the hinge tooth the shortest, beneath the beaks; the other longitudinal, beneath the insertion of the cartilage.

Chama calyculata, Linn. *Cardita variegata*, Brug. *List.* Tab. 347, Fig. 84, may be taken as the type of this genus.

These shells are irregular in their forms, and have two marks of attachment.

C. aspera, and *C. avicularia*, are the only species noticed by Lamarck, as found fossil near Paris.

CV. *Isocardia.* A heart-formed shell, with separated, involuted, and diverging beaks. The hinge formed by two flattened cardinal inserted teeth, and an isolated lateral tooth under the cartilage slope.

This genus includes the *Chama cor*, Linn. I am not acquainted with any shells, decidedly of this genus, having been found in a fossil state; casts, however, of shells very similar, are frequently found, and have been distinguished as *bucardites.*

CVI. *Cardium.* An equivalved subcordated bivalve, the valves dentated or plicated on their internal margins. The hinge formed by middle and lateral teeth: the middle ones, two, oblique and approximating, those in each valve, crucially receiving each other, by mutual insertion; those of the side, remote and inserted.

The shells of this genus are strongly characterized by the teeth of their hinge, and by the projection of their beaks; the latter giving them a cordiform appearance. They are generally ornamented with longitudinal ridges, more or less prominent; and frequently with striæ, scales, or spines. The marks of attachment are two in number, and are but faint.

Specimens of a cardium, resembling *C. æolicum*, Linn. figured by Lister, Tab. 314, No. 150, are sometimes found among the interesting fossils of the whetstone pits, completely silicized; and still retaining, very distinctly, the striæ, disposed longitudinally, in the fore part, and transversely in the posterior part.

Among the fossils of Plumstead is found a cardium, striated exactly in the same two directions as the preceding; but the striæ, especially the transverse ones, are much more minute and faint than those of *C. æolicum;* agreeing in this respect, and indeed in all its characters, with *C. discors*, Lam. Plate XIII. Fig. 3, is a representation of the silicized shell of Devonshire, resembling *C. æolicum.*

In the Harwich or Essex cliff, a shell somewhat like to *C. muricatum*,

is very frequently found. Among the Hampshire fossils is a very curious cardium, *C. porulosum*, Brand. on the longitudinal costæ of which are disposed thin, carinated, and crenulated plates, which are perforated at their base. *C. discors*, *C. porulosum*, *C. asperulum*, *C. calcitrapoides*, *C. oblicuum*, *C. granulosum*, *C. lima*, and *C. heteroclitum*, are given by Lamarck as the species found in the environs of Paris.

CVII. *Crassatella*. An equivalved inequilateral, close bivalve. The hinge teeth, two, with an adjoining pit: the lateral teeth obsolete. The cartilage inserted in a pit formed in the hinge.

The genera *Crassatella*, *Lutraria*, and *Mactra*, agree in having the cartilage of the valves interior, and attached to the hinge-pit of each valve; but this genus differs from the other two, in there being no gaping when the valves are shut.

C. tumida, Pl. XIII. Fig. 2, much resembles a recent species of this genus, which was found at King's Island, in the South Seas, by M. Peron. The shells of this, as well as of some other species of this genus, acquire a considerable degree of thickness with age. One specimen which I possess, from Grignon, which is about three times the size of that which is here delineated, weighs nearly half a pound. *C. lamellosa*, Lam. has been supposed to be the same shell, which is figured by Brander, among the Hampshire fossils, as *Tellina sulcata*, Fig. 89; but the English shell differs, in its form, from the French one, according to the specimens in my possession: the English one terminating, at its anterior side, in a more determinately pointed rostrum than the French one does. This, however, may be only the difference of a variety. *C. compressa*, Lam. resembles the species just mentioned, except in being less elongated transversely, and in its ridges being much smaller and closer. Four more species, *C. sulcata*, *C. gibbosula*, *C. lævigata*, and *C. triangularis*, are found in the neighbourhood of Paris.

CVIII. *Paphia*. A subtransverse inequilateral shell, with close valves, and having the cartilage internal. The pit for its insertion is under the beaks, between or beside the teeth of the hinge.

Venus divaricata, Linn. illustrates this genus, of which I do not know that any fossil specimens are known.

CIX. *Lutraria*. A transverse inequilateral shell, gaping at the extremities; two oblique and diverging hinge-teeth accompanying a large pit for the cartilage. No lateral teeth.

Lutraria elliptica, *List. conch.* Tab. 415, Fig. 259, is taken by Lamarck to illustrate this genus, which is, I believe, unknown.

CX. *Mactra*. An equivalved, inequilateral, transverse bivalve, a little gaping at the sides; the hinge-tooth complicated, with an adjacent little pit; the lateral teeth rather remote, compressed, and inserted: cartilage internal, inserted in the pit of the hinge.

The mactræ are marine shells, and do not appear to have been frequently found fossil. Lamarck describes but one species, *M. semisulcata*, as found fossil in the neighbourhood of Paris. The only English fossil-shell of this genus, with which I am acquainted, is one which is found in the Essex bank of fossil shells.

Two circumstances served to give some degree of ambiguity to this shell: the great width between its strongly projecting transverse ribs, and the structure of its lateral teeth; which, as in those of the genus *Trigonia*, were transversely sulcated: the two flat diverging teeth of the left valve on their outsides, and the flat receiving teeth on their inside. But Mr. Pennant, *British Zoology*, *No.* 43, *A*, observes, that in dead shells of *M. solida*, the striæ appear like high ribs; and I was surprised to find, on examining the teeth of the recent shells of this species, that a similar structure with that observed in the teeth of the fossil specimen is perceptible—a circumstance which has not been generally noticed.

CXI. *Erycina*. An equivalved, inequilateral, transverse bivalve. The hinge-teeth, two, diverging upwards, with a small intermediate pit; the lateral teeth compressed and oblong. The cartilage inserted in the hinge-pit.

The cartilage of these shells is inserted interiorly, as in the mactræ,

lutrariæ, crassatellæ, &c.; but a generic difference, in the opinion of Lamarck, exists in these shells: the cartilage is inserted in a pit between the hinge-teeth. He believes that the shells of this genus are only found fossil, and enumerates eleven species found in the environs of Paris: *E. lævis*, *E. pellucida*, *E. trigonia*, *E. inæquilatera*, *E. fragilis*, *E. elliptica*, *E. undulata*, *E. pellucida*, *E. obscura*, *E. miliaria*, and *E. radiolata*. Plate XIII. Fig. 13 and 14, are representations of the inner and outer sides of *E. lævis*, copied from Lamarck.

CXII. *Petricola.* A transverse inequilateral shell, gaping a little at both ends, and having two muscular impressions: two hinge-teeth on one valve, and a bifid one on the other. The cartilage external.

Venus lithophaga, Linn. is given as a species of this genus, which has not been described in a fossil state.

CXIII. *Donax.* An equivalved inequilateral bivalve: the fore side the bluntest. The hinge-teeth two, either in one or both valves: the lateral teeth one or two, rather distant.

The shells of this genus are strongly characterized by their nearly triangular figure, derived chiefly from the obtuse, and, as it were, truncated form of the fore side. When they have two lateral teeth, they are situated one on each side, with the hinge-teeth between them. The hinge-teeth themselves are sometimes two on each valve, and sometimes there are two on one valve, and but one on the other.

Lamarck describes the following species as having been found in the neighbourhood of Paris: *D. retusa*, *D. incompleta*, *D. tellinella*, *D. nitida*, *D. lunulata*, and *D. obliqua*.

Plate XIII. Fig. 6, is a very small specimen of a fossil-shell which is very frequently found in Gloucestershire and Somersetshire, near to Bath. I have introduced it in this place, not knowing one more appropriate, and trusting that its form may excuse a temporary disposal of it here, until a more satisfactory examination may detect its real characters; which, I think, will be found different from those of any known recent shell

The sacrifice of a great number of these shells, large and small, in search of the hinge, has been without success, excepting that, in one specimen, I have ascertained the presence of a lateral tooth, beneath the depression for the cartilage, on the truncated side.

These shells are sometimes found of a prodigious size—eight or nine inches long, and as many in width. One before me, which I purchased from the collection of the Marquis of Donegal, and which is, I believe, from the neighbourhood of Bath, weighs, with the inclosed lime-stone, nine pounds and a quarter.

Here we must also place the thick fossil shell represented Plate XIII. Fig. 7, which is also chiefly found in the counties just mentioned. This specimen is interesting; as it shows, from the valves having slipped from each other, the strong, boldly-projecting, lateral teeth, one of which is to be seen on each side. I had the mortification of destroying many good specimens, without gaining any further information respecting the hinge of this shell. But after obtaining the specimen which is here figured, I renewed my endeavours, and at last succeeded in separating two valves: by which I ascertained the existence of two lateral teeth, mutually entering, in each valve, and two thin cardinal teeth, converging, under the beaks of one valve, between which a single tooth in the other valve is inserted.

Here I will also, for the present, dispose of the curious and anomalous shell, Plate XIII. Fig. 8. The imperfect, and perhaps delusive view, in which this shell, the only specimen I have seen, is presented to my view, makes me hesitate at the endeavour to point out its apparently peculiar characters. It is a transverse inequilateral shell: the valves thinly beset with transverse linear ribs; and at little nearer to the base of the shell than the middle of the valve, on each side, is a flat ear-like process, by the continuation from which the superior part of the valve gains more than the eighth of an inch in width on each side. There is not any tooth discoverable beneath the beak; but the hinge appears to have been formed, at least in one valve, by a groove formed in an

arch, comprising the whole of the lower margin of the shell, with two remote projecting lateral teeth. Whether there exists in the other, as I believe, a ridge corresponding with the groove in this valve, or whether it was opposed by a corresponding groove, must remain to be ascertained by the examination of some more illustrative specimen.

CXIV. *Trigonellites.* A slightly-rounded, trigonal, thick shell, gaping on each side. The anterior margin nearly on a straight line; the posterior in a gently waving, and the upper side in nearly a circular direction. The outer surface of each valve thickly pierced by foramina, which, passing nearly through its substance, gives it the cancellous appearance of bone: the inner surface smooth, but marked with striæ, concentric with the upper margin. The hinge completely linear, without teeth; there being only an appropriate surface, on the anterior margin of each valve, for the attachment of the cartilage externally. No appearance of muscular attachment.

This shell, which I have presumed thus to name and to dispose of, is exceedingly anomalous in every respect: it is of an extraordinary degree of thickness, being, in some specimens, full three-eighths of an inch thick; and, even in young specimens, full a quarter of an inch thick. A fossula, or at least a greater degree of concavity, is observable just beneath the beak, and which is the only part which bears the least appearance of the animal having been attached to it. Possessing both valves, I have carefully sought to discover the state in which they would be, if united; but can only ascertain, that if brought into contact at the angular points, by approximating first the anterior sides of the valves, the shell gapes on each side, the rotundity of the shell occasioning a separation as the shell closes, of even the anterior margins, which are formed nearly on a straight line; and which, when the valves are widely open, lay in a line with each other, as at Plate XIII. Fig. 10 and 11. If the superior margins, which alone can be thus brought into contact, are placed together, the shell is very widely separated at the beaks.

This shell was first noticed by Scheuchzer as *Concha fossilis*

tellinoides porosa lævis, and is thus spoken of by this writer :*—" Ex plurimis conchis lapideis atque conchitis in Helvetia passim reperiundis, quorum descriptionem *Operi* ipsi *Historico-Helvetico-Naturali* reservo, aliquos duntaxat sisto, rariores scilicet, et ab aliis non, vel obscurè descriptos, quos inter primùm commemoro *Concham fossilem Tellinoidem*, ita mihi nuncupatam quia cava est, sui similem marinam, planè repræsentans, et Tellinæ formam rhomboidalem exprimit; ab una cardinis parte, eáque nunc dextra, nunc sinistra (unde non univalvem, sed bivalvem quoque dari, vel primitus fuisse conjicio) longiùs excurrit alterutrum latus, idque recta prorsus lineâ, dum latus brevius nunc sese incurvat, nunc, et plerumque, rotundat. Structuram quod attinet, est ea rara admodum, porosa, πολύτρητος, poris non in superficie tantùm conspicuis, sed totam eamque insignem crassitiem perforantibus, eo plane modo, quo astroitarum pori et stellulæ totam plerumque massam penetrant. Cavitas interna est lævis, et tamen lineis ab uno latere ad alterum transversim excurrentibus notata.—Cæterum friabilis est et ita fragilis ut rarissime reperiatur integra, nunquam prorsus bivalvis, et ideo lapidis nomen vix promereatur, nisi porosioribus et mollioribus accensere illam velis. Habeo et frustulum conchæ violentiâ quadam contortæ seu compressæ. Color plerumque est cinereus, aliquando subpurpureus, et rubiginosus."

M. Walch says very little respecting this curious fossil. M. Bertrand, with M. Davila, suspected these fossils to be the valves of a shell resembling *Lepas anatifa;* forming their conclusions on the accordance of their figure with that of the valves of the *Lepas*, and on the two valves not being found together, as they think would be the case if the shell was a bivalve. Baier, however, has engraved six or seven specimens in which the two valves have been found together, although open. *Monum rer. petrif.* Tab. XIV. This author considers these shells as *Chamæ* and *Tellens;* even referring one species to *T. rostrata*, Linn. Neither Lamarck nor Faujas St. Fond have made any mention of this shell.

* Specimen Lithog. Helvet. p. 21.

From the figures given by Baier, two distinct species of this genus may be made out; each of which I have been able to identify with specimens in my possession. The first of these, of which I have given a representation of the appearance of the outer surface, Plate XIII. Fig. 12; and of the inner, Fig. 9, and which is by far the most common species, I will distinguish as *T. lata*. The breadth of this shell is not much exceeded by its length, and its outer surface appears to have been quite smooth, the pores seeming to show themselves only where the original surface has been removed by attrition or decomposition.

The specimen represented Plate XIII. Fig. 10, which may be named *T. lamellosa*, is particularly instructive. More anxious to ascertain its specific characters than to preserve the specimen, however curious, I succeeded, with much care and time, in removing a sufficient portion of the lamellæ of its calcareous matrix, to enable me to discover the structure on the outer surface, which I found exactly to agree with that which is shown in Fig. 11, and which of course evinced that both these shells were of the same species.

Whilst attempting the removal of the matrix from another specimen of this species, I was surprised at finding in the stone a spathose substance ramifying from the upper margin of each valve, near to the posterior margin, and extending nearly half an inch from the shell. On applying the muriatic acid to this substance, the odour soon convinced me of the presence of animal matter. Hence I was led to endeavour at the removal of the matrix in the present specimen, Fig. 10, with a hope of determining whether it possessed a similar appendage. My exertions proved so successful, as to allow of the exposure of this substance proceeding from both valves, as shewn in the same figure. A more rigid examination of the valves of the preceding species, *T. lata*, after this discovery, showed that, on the correspondent part of the valves, a scabrous surface existed, which, in all probability, had been the surface of attachment for this peculiar substance. But whether this extraordinary substance should be considered as extraneous, or as actually

belonging to the shell, is a point on which I am unable to give a decided opinion: the determination must, therefore, be left to those who may have better opportunities of pursuing the inquiry.

A specimen is figured by Baier, resembling *T. lata* in form, but which is much smaller, and appears to be marked externally with transverse striæ. Whether this is only a young one of the species *T. lata*, is difficult to say; but in one of my specimens, is an impression of the two opened valves of a small shell, in which I observe an exact agreement with the proportions of the valves of that species. In this specimen I also observe traces of the impressions of a similar appendicular substance with that already noticed.

CXV. *Venus.* An equivalved, rather inequilateral bivalve, with three hinge teeth in each valve, converging at their base towards the beaks. The middle tooth, which is sometimes bifid, is placed straight, and the one on each side obliquely.

Lamarck particularizes six fossil species, which are found in the neighbourhood of Paris: *V. mutabilis, V. obliqua, V. callosa, V. texta, V. scobinellata, V. puellata.* Of the first of these, *V. mutabilis,* he observes, that it is the most singular shell which he knows, with respect to the variety which it exhibits in its hinge. It is a roundish, elliptical, transverse, compressed shell, bearing only very fine striæ on its surface, the marks of its increase; the hinge, in old shells, without teeth. In the young specimens, the three teeth, characteristic of the genus, are generally observable; but, even among these, one or two of the teeth are sometimes effaced. On viewing the older specimens, the teeth are so frequently absent, that it might be supposed, that none belonged to the species. On the inside of the valves are very fine serrated and radiating striæ; but which, not reaching to the edge, leave it smooth.

Among the admirable silicized shells of Devonshire is found a fossil, which appears to be undoubtedly referable to *Venus castrensis.* In a specimen with which I was favoured by Mr. Clarke, the shell is per-

fectly silicized; and, in the transparent parts, the angulated tent-like characters are beautifully shown in white and opaque markings.

In the Essex bank I met with a fine specimen, which exactly agrees with *V. Scotica*, described by Dr. Maton and Mr. Racket, in the Linnean Transactions, Vol. VIII. p. 81, t. 2, f. 3, except being double the size of the recent shell. Like that shell, it is thick, subcordated, subcompressed, with many regular, parallel, transverse ridges: *umbo* reclined: cordiform depression lanceolate. Inside glossy; teeth strong, oblique: margin plain. Length full an inch; breadth nearly an inch and a quarter.

Among the fossil shells which I obtained from the collection of Mr. Strange, are specimens which are marked *Maryland;* and which appear to agree very closely in their characters with *V. Mercenaria.*

At the sale of Dr. Menish's collection, I purchased a very large shell of this genus, measuring four inches and a half in length, and four inches three quarters in width. Its approximation, in form, to the preceding shells, but having no cordiform depression, and a plain margin, are circumstances which seem to allow of its being considered, at least, as very like to *V. islandica.* I am unacquainted with where it was obtained.

I was favoured by Captain Gardiner, from the same collection, with a shell exactly agreeing, in its specific characters, with the preceding, but being of rather a less size. This shell is one of the Blackdown fossils: it is nearly perfect, and, although its outer surface has suffered some little decomposition, by which it is rendered of a dead white, yet the whole substance of the shell being now a clear calcedonic substance, the thickest part of the shell is in some degree translucent.

The lateral teeth do not, I think, exist with sufficient distinctness in either of these shells, to warrant their removal to the genus *Cyclas.*

CXVI. *Cytherea.* An equivalved and rather inequilateral bivalve. The hinge with two or three approximated teeth, converging at the

base; with a distant one under the cordiform depression, in one valve, and a little pit for its reception in the other.

The general form of these shells agrees with that of the shells of the preceding genus; but the isolated tooth, and the corresponding pit, afford characters certainly sufficient for disposing them under a distinct genus, under which Lamarck places *V. meretrix*, *punctata*, *lusoria*, *læta*, *pectinata*, *tigerina*, *chione*, and indeed all those which have a tooth distinct from the cardinal ones. He particularizes nine species found fossil in the neighbourhood of Paris: *C. scutellaria*, *C. demisulcata*, *C. nitidula*, *C. polita*, *C. lævigata*, *C. tellinaria*, *C. elegans*, *C. deltoidea*, *C. corbulina*.

In the Essex and Suffolk bank is a fossil shell of this genus: it appears to resemble, in its specific, as well as in its generic characters, *Venus exoleta*, Linn. *List. Conch.* t. 292, Fig. 128.

CXVII. *Cyclas*. An ovato-transverse bivalve, not inflected on the fore part: the hinge with three hinge-teeth and two lateral ones, compressed, and rather remote.

The shells of this genus are chiefly river shells, some of which have hitherto been placed under the genus *tellina*, and others under *Venus*: but having no fold on their anterior part, they are not referable to the former; and having two lateral teeth, they cannot be placed under the latter genus.

Lamarck describes the *Cyclades* of Europe as small, thin, and, as it were, horny, with the hinge-teeth not very distinct. It is from these shells that Linnæus has taken his species *tellina cornea*. The exotic *Cyclades*, and particularly those of Asia, are very large, and have their hinge-teeth very distinct, and very often bifid. Amongst these he places *Venus coaxans*, *V. islandica*, and several other shells, which have been hitherto placed under the genus *Venus*.

Very few other bivalves are to be found in that vast stratum of shells extending so widely from Woolwich, except a shell, which I think is decidedly referable to this genus, and perhaps to the species

C. deperdita, the only fossil species mentioned by Lamarck. Like this species, the Woolwich shells are ovato-transverse, and marked with very small transverse striæ, indicating the stages of growth. They have three teeth at the hinge, and two compressed lateral teeth in one valve, with grooves for their reception in the other valve. Like the French fossil shells of this genus, the Woolwich also are entirely white, being without epidermis or animal matter.

Having obtained a mass of shells of this genus, imbedded in pyrites, from the Isle of Wight, I was surprised at finding that their lateral teeth, like those of the *Mactra solida,* were transversely grooved, the penetrating teeth on the out, and the receiving teeth on the insides.

Plate XIII. Fig. 5, represents the valve which is furnished with the penetrating grooved lateral teeth, from the Isle of Wight.

CXVIII. *Venericardia.* An equivalved, inequilateral bivalve, ribbed longitudinally on the outside, with two thick hinge-teeth, disposed obliquely, and in the same direction.

In some species, deserving, perhaps, as Lamarck observes, to be considered of another genus, there is but one tooth on one valve, and two diverging teeth on the opposite valve.

These shells are strongly characterized by their having longitudinal ribs, as in the cockles and scallops. They are marine shells, and have two muscular impressions.

The most beautiful species of this genus is *V. planicosta,* a remarkably thick shell, obliquely cordated, with flat smooth longitudinal ribs, and which Lamarck describes as being sometimes three inches and a half in length. The shells of this species are found in the neighbourhood of Paris, but are there but small. At Piedmont, and in the neighbourhood of Florence, they are found of the largest size: one specimen I have, which measures full four inches and a half. These fossil shells are found of a very handsome size on the Hampshire coast: Mr. Holloway, of the Custom-house, Portsmouth, has kindly favoured me with specimens from Selsea, one of which measures nearly three inches and a half in width.

V. acuticosta differs from the preceding chiefly in having its ribs somewhat carinated; Lamarck, indeed, suspects it to be merely a variety.

V. senilis. Lam. is a thick obliquely cordated shell, about an inch and a half in length, with large convex, rather imbricated, but not rough, ribs. The specimen possessed by Lamarck, he believes, was obtained from Courtagnon. It is frequently found among the Harwich shells, and in very good preservation. Its thick valves, with large smooth ribs, give to it a very antiquated appearance. The outer and inner side of one of these shells are figured Plate XIII. Fig. 15 and 17. Lamarck particularizes two more species, *V. multicostata, V. pectuncularis;* besides four more, *V. cor avium, V. squamosa, V. decussata,* and *V. elegans;* in which only one hinge-tooth is apparent in one valve, and which is received by two corresponding but diverging teeth in the opposite valve.

CXIX. *Lucina.* A round, or ovato-transverse equivalved bivalve, with the beaks bowed backwards. The hinge-teeth, one or two, variable; the lateral teeth one or two, and sometimes hardly any.

These shells differ from Venus's, in having lateral teeth; from Tellens, in having no fold; and from Cyclades, in not having three hinge-teeth. Lamarck reckons twelve species as found in the neighbourhood of Paris: *L. lamellosa, L. concentrica, L. circinaria, L. saxorum, L. divaricata, L. gibbosula, L. renulata, L. albella, L. sulcata, L. squamosa, L. undulata, L. complanata.*

This genus was instituted by Bruguiere for the reception of those shells which, with only one or two cardinal, had one or two lateral remote teeth, which in some species were hardly apparent. *Tellina pectinata*, Linn. *Conch. Listeri*, Pl. 300, Fig. 137, is one of this genus. *V. fimbriata*, Linn. *V. Pensylvanica*, Linn. with *T. lactea*, Linn. and *T. divaricata*, have been also placed in this genus.

A small shell, resembling *V. gallina*, found among the Harwich fossils, seems to have the characters of this genus.

CXX. *Tellina.* An orbicular, or ovato-transverse equivalved bi-

valve, with a fold on the anterior part, and short beaks. One or two hinge-teeth, and remote lateral teeth.

The shells of this genus are chiefly known by the inflexion or irregular fold on their fore part. The hinge-teeth are either one on each valve; two on one, and one on the other; or two on each valve: and the lateral teeth are most frequently two, which are compressed.

Lamarck particularizes the following, as being the species which are found in the neighbourhood of Paris: *T. patellaris*, much resembling *T. remies*, Linn. *T. scalaroides*, *T. carinulata*, *T. sinuata*, *T. donacialis*, *T. rostralis*, *T. corneola*, *T. pusilla*, *T. rudis*.

The *habitat* of the rostrated shell, represented Plate XIII. Fig. 4, I am not acquainted with; nor, though I have placed it here, am I satisfied of this being its most appropriate place, being entirely unacquainted with its hinge.

CXXI. *Capsa*. A transverse shell, with two cardinal teeth in one valve, and one entering double tooth on the other.

This genus is exemplified by *Venus deflorata*, or *Capsa rugosa*, Linn. *List. Conch.* Tab. 425, Fig. 273. The shells of this genus are not, I believe, known fossil.

CXXII. *Solen*. An equivalved, transversely elongated bivalve, gaping on each side; the hinge-teeth single in each valve, or double in one valve; the beaks exceedingly small; the ligament external, and most frequently near to the extremity of the shell.

The *sanguinolariæ* are distinguished from the *Solens* by having two hinge-teeth in each valve; the *glycemeres*, by having no hinge-teeth; and the *myæ*, by having an inner ligament, and by their projecting compressed tooth in the left valve, to which the ligament is attached.

Lamarck describes five fossil species of this genus, as found in the environs of Paris: *S. vagina*, *S. fragilis*, *S. effusus*, *S. strigilatus*, *S. appendiculatus*. Of *S. vagina* he remarks, that he found none more than three inches in their transverse length. *S. fragilis* approaches

very nearly to *S. Cultellus*, Linn. *S. effusus* bears some resemblance to *S. vespertinus*, Linn. *S. strigilatus* appears to be similar to the recent shell of the same name. *S. appendiculatus* is a small smooth elliptical shell, the recent analogue of which is unknown. It derives its name from a little process which projects near the beaks.

Fragments of shells of this genus are found in the Essex cliff. From a considerable number of these I have been able to make out only two species resembling *S. siliqua*, Linn. and *S. ensis*. It is remarkable, that in the fossil shell agreeing in the characters of its hinge with *S. siliqua*, a proportionate shortness in its transversal length is observed with that of the fossil *S. vagina*, described by Lamarck. In one valve of this species, which I am able to say must have measured nearly an inch in its length, from its inferior to its superior edge, the breadth from the anterior to the posterior termination is only two inches and three quarters. The fossil resembling *S. ensis*, appears to vary from it only in not being quite so much bowed as the recent shell.

CXXIII. *Sanguinolaria.* A transverse bivalve, arched on its superior edge, and gaping a little at its extremities. Two hinge-teeth, approximate and articulating, on each valve.

This genus is exemplified in *Sanguinolaria rosea*, *Solen sanguinolentum*, Linn. *List.* t. 397, Fig. 236. The shells of this genus are distinguishable from those of *Solen*, only by their having two teeth in each valve. I am not aware of their having been found fossil.

CXXIV. *Glycemeris.* A transverse shell, gaping at both extremities: hinge callous, without tooth. This genus is exemplified in *G. incrassata*, Lam. *Mya siliqua*, Chemn.; but I am not acquainted with any species of it as a fossil.

CXXV. *Mya.* A transverse bivalve, gaping at both ends; ligament internal. The left valve with a hinge tooth, compressed, rounded, perpendicular to the valve, and giving attachment to the ligaments.

Lamarck has not met with any shell of this genus, in a fossil state, in the environs of France.

A very handsome fossil shell, apparently of this genus, is found in the cliffs at Bognor; but as I have never been able to view the interior part, although I have destroyed several specimens for the purpose, I am unable to speak decidedly with respect to it. Fragments of the hinge part of a shell of this genus, are sometimes found in the neighbourhood of Norwich.

CXXVI. *Panopæa.* A transverse inequilateral bivalve, gaping unequally at the ends. The hinge similar in both valves, having a large elongated tooth placed under the cartilaginal depression, running along the interior edge in a raised blunt margin, and projecting posteriorly; a conical hinge-tooth, rather flat and bent; and on the right valve, a little pit, which receives the tooth of the opposite valve. The ligament exterior; the beaks but little projecting; the depression large. Two muscular impressions in each valve, towards the extremities.

This genus was formed by M. Menard de la Groye, on a shell found in Mount Pulgnasco, in the commune of Diolo, in Parma, in a fine-grained quartzose sand, mixed with a greyish clay. Of this shell, some beautiful specimens have been collected by M. Cortezi, of Parma. On clearing the hinge from one of these, which had been presented to M. Faujas, M. Menard was very much surprised to find that it was a shell of a mixed genus, resembling both *Mya* and *Solen.* This shell is about three inches and eight lines in length, and six inches and three lines in width. The outside is smooth, being only transversely grooved by the successive additions of new shell. On the inside, along the edge, and particularly the upper edge, is a callous smooth kind of border; and, further into the cavity of the shell, is another surface, more or less rugose, which marks the parts where the animal was attached. *Annales du Mus.* Tome IX. p. 131.

A recent shell of this genus, but undoubtedly of a different species from the fossil shell described by M. Menard, has long been known to the conchologists. It was first figured by the indefatigable Aldrovandus, who gave to it the name of *Chama glycemeris, Testac.* lib. III. p. 472.

The figure of Aldrovandus has been copied by Bonanni, Gualtieri, Klein, and others. Lister has given a copy from Aldrovandus, *Hist. Conch.* T. 414, Fig. 258; and Baron Born has given a correct figure from a shell in the cabinet of Vienna, *Mus. Cæs. Vind. test.* T. I. Fig. 8. Aldrovandus relates that the shell which he described was found in the Mediterranean, on the coast of Spain.

This shell is exceedingly rare: M. Menard observes, that it is not in any of the Parisian collections, not even in the Museum of Natural History; and that he knew of but one in the possession of M. Pech, whose cabinet was sold to the Emperor of Austria. The particular characters of this shell demanding its being placed in a new and distinct genus, were fully noticed by Baron Born, who says "Ob extremitatem utramque hiantem Solenibus affinis, a quibus dente exserto crassissimo differt." *Mus. Cæs.* p. 20.

M. Pech, on comparing the characters of his recent shell with those of the fossil one, was of opinion that, in general, they agreed; and particularly that the hinge was the same. But he found that the recent shell was wider and less tumid, in proportion to its size, than the fossil one, and that it gaped at both ends, but less at the posterior than at the anterior part; whilst, in the fossil shell, the opening in the posterior part was hardly discoverable. From this comparison, M. Menard concludes, that the recent and fossil shells are of distinct species: the propriety of which conclusion will at once be seen, on a view of the figure given by Born, and of that given by M. Menard. The species to which the recent shell belonged he named *Panopea Aldrovandi;* and that to which the fossil shell was referable, *Panopea Faujas.*

Among the fossil shells which I had purchased from the collection of Mr. Strange, was a valve, which I had valued from its resemblance to the shell of Aldrovandus; but of the *habitat* of which I could obtain no other information than the word *Maryland*, which was written on its inner surface. On reading M. Menard's account of the Parmese

fossil, I again examined this valve. A slight view of its characters evinced that it belonged to the same genus: its hinge, its broad surface on the inner margin, and the broad, rougher surface to which the animal adhered, all agreed.

Its much closer agreement with the *Panopea* of Aldrovandus than with the *Panopea* of Faujas, was directly manifest. The closed valves must have gaped widely at both ends, and could not have made that approach to the cylindrical form which is observable in the latter shell. That it did not belong to a shell of the same species with the fossil shells of Mount Pulgnasco, is certain; and that it is a valve of a small individual of the species *P. Aldrovandi*, is highly probable: there would, indeed, exist no doubt on this point, but that a little difference exists in the outline of the two shells, which however may depend on their different stages of growth. A representation of this fossil valve is given Plate XIV. Fig. 1. It has suffered a greater degree of decomposition than the fossils of Parma, and has lost the point of the smaller tooth.

The fossil shell represented Plate XIII. Fig. 16, is particularly interesting from the very uncommon manner in which it is marked. It is little more than a cast; being formed of a dark grey lime-stone, to which it appears that some of the inner plate of the shell has adhered, and has acquired a film of yellow pyrites.

The valves having slipped before the forming of the cast, and hardly any of the shell itself remaining, it is impossible to determine under what genus this fossil should be placed.

It is a transverse, regular formed, and, apparently, an equivalved shell, which has been marked with round, closely-set grooves, passing obliquely from the anterior and posterior sides; the nearest to the centre meeting and forming an angle, the others terminating in the upper margin of the shell.

I was favoured with this fossil by the Reverend Mr. Marsh, of Felmersham House, Bedfordshire, who found it in that neighbourhood.

M. Walch describes a similar fossil, *Supp.* Pl. v. c. p. 151, as a very rare shell, which was found at Guntershofen, and which, he thinks, might be very well placed among the tellenites. A similar fossil had been previously found at Neustrelitz, in Mecklenbourg, in a grey lime-stone, and described and figured in *Magazin de Berlin*, t. IV. This shell M. Walch describes as having the point of the hinge elongated; and striæ, or raised, elongated, and rather oblique ribs, of which, those which are nearest the hinge unite and form an angle. The analogue of this shell, he observes, has not yet been found. M. Martini observes, with respect to this shell, that he has never seen any recent or fossil shell resembling it, having these converging striæ, in the form of a bow, with cordiform interstices.

LETTER XIV.

PHOLAS. . . . FISTULANA. . . . TEREDO. . . . . DICERAS. . . . . ACARDO. . . . RADIOLITES. . . CHAMA. . . . SPONDYLUS. . . PLICATULA. . . .GRYPHÆA . . . . OSTREA.

LAMARCK, in his *Systeme des Animaux sans vertebres*, had placed *Pholas* at the end of the equivalved shells, and characterized them as having accessory pieces; and the genera *Teredo* and *Fistulana* he placed at the head of the inequivalved shells, and distinguished them as having the principal valve tubular.

Since that period, in his *Suite des Memoires sur les Fossiles des Environs du Paris*, under the article *Fistulana*, he says, that he was for a long time perplexed, whilst endeavouring properly to characterize this singular kind of shell, because he considered, as all other naturalists had done, the tubular sheath which enclosed the animal

and its real shell, as the shell itself. But making further researches, he perceived a considerable agreement between the valves of ***Modiola*** and those of ***Fistulana;*** and learned that some fistulanæ passed out of their proper tube, and lived in the tubular cavities formed in stone and other solid bodies, those cavities supplying the place of their own. Hence he concluded, that the two equal valves which adheres to the animal, formed the true shell of ***Fistulana;*** and that the shelly tube should only be regarded as an accessory piece, forming the cavity in which the animal was to reside.

On this principle, he thinks that the tube of the ***Fistulana***, ***Teredo***, and ***Penicillus***, as well as the accessory portions of shell of the ***Pholas***, should be considered as objects independent of the general character which should be employed in the classing of these animals, and therefore should be used only in the distinction of their genera*.

Agreeable to this arrangement, we will proceed to the consideration of equivalved bivalves with accessory pieces.

CXXVII. ***Pholas.*** A transverse gaping shell, composed of two large principal valves, with many small accessory pieces placed on the ligament or at the hinge.

Among the Essex fossils are frequently found fragments of P. *crispata;* but, from the extreme brittleness of the shell, the fragments are in general but small. I have, however, on a late trip to Walton, been so successful as to obtain a fragment or two, possessing the recurved tooth, which, together with the crinkled surface, leaves little room for doubting it to be of the species ***P.*** *crispatus.* I also obtained a small perfect shell, which from its form, and the fineness of the striæ with

* Agreeable to this last decision of Lamarck, ***Penicillus*** should be placed among the bivalves instead of among the tubular shells, as it will be found in the eighth Letter. But one circumstance seems to render the propriety of its removal to this place doubtful—the valves in the genus *Penicillus* are incrusted in it, and form a part of it; consequently, as they cannot perform the office of valves, the dwelling of the animal may be rather considered as a tubular than a bivalve shell.

which it is marked, I am disposed to consider as ***P. campechensis***, *List. Conch.* Tab. 432, Fig. 275.

CXXVIII. ***Fistulana.*** An equivalved bivalve, gaping, nearly toothless shell, included in a club-formed testaceous tube, open at the smaller end.

The bivalve of the ***Fistulana***, as may be seen by its representations, Plate XIV. Fig. 2 and 4, bears a considerable degree of resemblance to the valves of ***Modiola*** : and it should be recollected, that some of the ***Modiolæ, Mytilus Lithophagus***, Linn. for instance, are found in cavities formed in stone. The tube of the ***Fistulana*** is completely closed at its larger end; whilst the smaller end is open, and has sometimes one side of it formed by one of the valves adhering to it.

We are much indebted to M. Faujas St. Fond for his researches respecting these fossil bodies, and for ascertaining the existence of these bivalves in their proper tube among the fossils of Grignon.

Lamarck describes four species of this genus as found fossil in the neighbourhood of Paris : *F. ampullaria, F. tibialis, F. echinata,* and *F. personata.*

The first of these, *F. ampullaria,* the tube of which is of the form of an elongated pear or bottle, and covered by a calcareous sand, has two ridges in the inside of its smaller part; and in this part is found the bivalve shell, resembling one of the modiolæ, and with a shining surface. The shell is sometimes found loose, and at other times united to the tube by interposed spathose matter.

Mr. Meade very kindly favoured me with the two shells of this genus, detached from their tubular parts, the representations of which have been just referred to. The same gentleman also obliged me with a mass of spathose lime-stone, in which several of these fossils are imbedded, with their containing ampullaceous tube. Pl. XIV. Fig. 6.

The fossil which is figured, Plate XII. Fig. 1, of the second volume of this work, to show its coralloid investment, as well as the ampullaceous bodies in Fig. 2, of the same plate, belong to this genus, and doubtlessly contain the two valves composing the shell; but here, as

in many other specimens, the included valves are most probably involved in spathose matter, which has crystallized within the tube.

Plate XIV. Fig. 7, is a very instructive specimen of this shell: the valves being there seen partly denuded of their including tube. This specimen I purchased from the Museum of Dr. Menish. It was found at Bradford, Wilts, in the white clay which covers the great Oolite rock.

I have now before me a fossil of this species from Malta, of which I have opened one side so much, as to give a pretty fair view of one of the valves, which is very nearly two inches in length, and has a very smooth surface. This shell evidently differs from the Bradford shells, Fig. 2 and 4, which again differ from each other, they forming, as it were, sub species. I have been favoured with calcareous masses, in which these fossils are imbedded, from Bedfordshire, by Mr. Goodhall and the Rev. Mr. Marsh; and from Wiltshire, by Mr. Cunnington.

In the *F. tibialis*, which is much larger than *F. ampullaria*, one of the valves is found adhering to one side of the tube. This valve is marked with unequal transverse striæ, which a magnifying glass shows are decussated by longitudinal, and sometimes punctuated striæ. The lower part only of this tube has been seen by Lamarck; and this seems to bear somewhat of the general form of the preceding species, although much larger.

In *F. echinata*, the bulbous end of the tube is irregularly beset with tubular points. On one part of its surface, which is bounded by a fringe of these spines, there occurs a small smooth space, and then another surface, beset with spines. On the other side, one of the valves is detected, set in the side of the tube. This valve, though apparently smooth, is discovered, by the glass, to be beset with minute scaly points, disposed in rows, directed towards the beaks. This fossil, as well as the other, was found at Grignon.

F. personata is very remarkable for the form in which its larger, or clubbed end, terminates. The tube, which is cylindrical in great part of its length, is seldom more than two or three inches long; becoming small at its open end, and being somewhat rounded at the other. At this larger termination it is closed, rounded, and very obtuse; and on

one side shows three conical lobes, the central one having a pyramidal form, the point terminating upwards, between the points of the two others, which meet like the beaks of a bivalve, yielding somewhat of the appearance of a grotesque mask, or of the figure which is assumed by some chrysalides; and on the point where these conical bodies unite is found, in some specimens, a piece of a particular form, disposed like the rotula of the knee. The opposite side of the tube is rounded like the back of the human head, and is marked by two oblique suture-like lines, which descend, and, uniting, seem to mark the termination of the head in the neck.

Plate XIV. Fig. 10, represents one of the largest-sized fossils of this species which I have seen, and the most contorted in its form. This, it is seen, has lost the rotula, which in the specimen, Fig. 8, is preserved. It is somewhat of a triangular form, disposed between the lateral lobes, and connected with the posterior surface by a narrow, and apparently corrugated process.

Whether the larger end of this shell was always closed or not, is very difficult to determine. It appears, however, not probable, that so complicated a form should have been without some use; and the rotula, it is very likely, might have been employed by the animal in a manner somewhat similar to that in which the spatula-formed opercula of the teredo was used.

In Plate XIV. Fig. 12, *a*, and 12, *b*, are represented two specimens of shells of this genus, from France. In the specimen Fig. 12, *a*, the sides of the tube are so removed, that the outer sides of both the valves are seen; and in Fig. 12, *b*, the inner side of one of the valves is shown, set in the side of the tube. So much of the outer part of the tube is removed, in these specimens, as to render it difficult to speak of the species to which they should be referred.

At first view, the echinated surface which they display leads to the supposition, that they should be considered as being of the species *F. echinata*, Lam.; but, on examination with a lens, it is discovered that the

appearance of tubular points proceeds from the remains of an investiture with that curious madreporean substance, which was figured, as forming a similar covering, in Plate XII. Fig. 1 and 2, of the second volume of this work. That this was the substance which gave the echinated surface in Lamarck's *F. echinata*, the accuracy of that naturalist prevents our supposing. A very remarkable circumstance, however, here presents itself for our attention—a similar fossil body, the tube of different species of fistulanæ, is found in different parts of Wiltshire and Somersetshire, in Germany, and in France, covered by the peculiar madreporean labours of an insect, traces of whose existence, elsewhere, are very rarely to be found.

CXXIX. *Teredo.* A bivalve shell, contained in the lower end of a cylindrical tubular shell, generally open at both ends, two opercula being adapted to the upper end.

Having already, in the first volume, dwelt upon the appearances yielded by the wood which has been subjected to the ravages of the inhabitant of this shell, and which has afterwards undergone the change of petrifaction, I shall only now place before you the very interesting observations of Mr. Home, on the anatomy of the *Teredo navalis*, and on that of the *Teredo gigantea*, of Sumatra, another species which has lately been discovered.

After a violent earthquake at Sumatra, in the year 1797, these shells were discovered in a small sheltered bay, with a muddy bottom, surrounded by coral reefs, on the Island of Battoo, distant from the coast of Sumatra about twenty leagues.

The length of the longest of the shells obtained by Mr. Griffiths, who brought them to England, was 5 feet 4 inches, and the circumference at the base 9 inches, tapering to 1½ inch at the point. The large end of the shell is completely closed, and has a rounded appearance: at this part it is very thin. The small end, or apex, is very brittle, and is divided by a longitudinal septum running down for eight or nine inches, forming it into two distinct tubes, enclosed within the outer one, from

whence the animal throws out tentacula. The body of the shell has an appearance resembling stalactites, and was found filled with a soft gelatinous flesh; but there appeared no indication of the animal having adhered to any part of the internal surface of the shell, which was in general smooth.

Rumphius has figured one species of this shell; but his figure exhibits two long jointed tubes, issuing from the upper part of the exterior tube; and he describes them to be found in shallow water, among the mangrove trees. The shell of Rumphius differs from that of Mr. Griffiths, in having the two tubes through which the tentacula pass, of considerable length, and entirely separate.

Sir Joseph Banks, on seeing this shell, had no doubt of its being a *Teredo;* and the truth of Sir Joseph's opinion has been since established by the discovery of the two boring shells and the two flattened opercula, which form the decided character of teredines: these, Mr. Home states, were found enclosed in one of the specimens. This shell is therefore considered by Mr. Home as belonging to a new species of *Teredo*, which he names *Teredo gigantea**.

On examining the *Teredo navalis*, whilst preserved in sea-water, Mr. Home found that the animal threw out sometimes one and sometimes two small tubes: one of these, about $\frac{3}{4}$ of an inch long, the other only half that size. In examining the shell, while in the wood, its external orifice is very small, just large enough to give a passage to the two small tubes. The sides of the cylinder are thickest near its origin, becoming thinner towards the head of the animal.

The head of the animal is enclosed between the two boring shells, which are united together by a digastric muscle. From the middle of the exposed part of the head projects a kind of proboscis, which there is reason to believe acts as centre bit.

The body of the worm is enclosed in one general covering, extending

* Description of a rare species of worm-shells, discovered at an Island lying off the North-West coast of the Island of Sumatra, in the East Indies. *Philosophical Transactions,* 1806.

from the base of the boring shells, with which it is firmly connected, to the root of the two small tubes, which appear out of the wood. It terminates in a small double fold, forming a cap, on the inside of which are fixed the long small stems of the two opercula, which become broad and flat towards their other extremity. These, when brought together, shut up the shell, and enclose the two contracted tubes within it: not one operculum corresponding to each tube, but in a transverse direction. In the *Teredo gigantea*, the opercula are similarly situated, each shutting up one half of the bifurcation.

The *Teredo gigantea* is found imbedded in a different substance from that in which the *Teredo navalis* is found, and may have many other characteristic differences; although it appears, from comparing the shells in which they are incased, that they are formed of exactly the same materials.

The *Teredo gigantea*, when arrived at its full growth, closes up the end of the shell. This, the *Teredo navalis* does also. In some of the specimens of *Teredo gigantea* the shell is just covered in, and that part close to the termination is extremely thin, but in others it is increased in thinkness twentyfold: in others, again, the shell has not only become thick, but the animal has receded from its first enclosure, and has formed a second three inches up the tube, and afterwards a third two inches on; and has made the sides thicker and thicker, to diminish the canal in proportion to the diminution of its own size.

These facts prove, that the *Teredo gigantea*, when arrived at its full growth, or whenever prevented from increasing its length, closes up the end of its shell, and lives a long time afterwards, furnished with food from the sea-water it receives, like the *actiniæ*. The *Teredo navalis* closes up its shell in the same manner: it must, therefore, after that period, be supplied with food entirely through the medium of sea-water*.

Whilst treating of serpulæ we found, that in those shells a similar pro-

* Observations on the Shell of the Sea-worm, &c. by Everard Home, Esq. *Philosophical Transactions*, 1806.

cess was sometimes performed with that which Mr. Home has here shown takes place in the shell of the toredo, and by which the size of the immediate residence of the animal is adapted to the size of the animal itself. But since the publication of the first volume, I have had the opportunity of ascertaining, that this concameration of the shell of the teredo occurs so closely, and with so much regularity, in some specimens, as to give reason for believing that it may become the character of a species. A specimen of this kind, in a piece of wood from Southend, Essex, is represented Plate XIV. Fig. 11; and I know that among the specimens of the British Museum, is a much larger specimen, possessing the same character.

A Veronese fossil in my collection is rendered deserving of notice by the very close resemblance which it bears to *T. gigantea*, in the markings and in the stalactitic appearance of its surface: it is about an inch and a half in diameter. Plate VII. Fig. 9, is a small fossil of a curious structure, the single tube bifurcating, and bearing somewhat, in miniature, of the appearance which is exhibited by the large teredo figured by Rumphius, in which two long tubes proceed from the exterior one.

The next subdivision of fossil bivalves, which requires our attention, is that which comprises inequivalved and irregularly formed shells.

CXXX. ***Diceras.*** A ventricose, transversely subrugose bivalve: the beaks distant, shaped like horns, and contorted in irregular spires.

The valves of this fossil shell are unequal, tuberous and conical, and somewhat resemble two cornucopiæ, turned spirally but irregularly, with their openings applied together. In the larger valve is the hinge-tooth, obtusely conical and very large and thick, resembling an ear with its cavity. This tooth is articulated, with a corresponding tooth in the other valve. Two lateral muscular impressions seem to point out its greater degree of relationship to the chamæ than to any other shells.

This curious fossil was found by M. Saussure, in the mountain Salève, in a calcareous stratum, *Voyage dans les Alpes*, Tome I. p. 190, Pl. II. Fig. 1. *a* 4. It was also found by M. de Luc, at about one third of the height of the mountain. But one species of this shell is known, ***D. arietina.***

CXXXI. *Acardo.* A shell formed of two flattened and nearly equal valves, having neither hinge nor cartilage, but a muscular impression in the middle of the valves.

This genus, which has been adopted by Bruguiere and Lamarck, was formed by M. Commercon, from a shell he discovered during his voyage round the world. The shell seen by M. Commercon was somewhat cordiform, and its substance appeared to be intermediate between shell and bone. Being attached to the centre of the two valves, the animal was able thereby to separate the valves, and in a parallel direction. Bruguiere reported that he had seen a shell of this genus in the Isle of France, the shape of which was nearly square. No fossil shell of this genus is known. *Hist. Nat. des Coq. par Bosc.* T. II. p. 325.

CXXXII. *Radiolites.* An irregular inequivalved shell, striated outwardly. The inferior valve in the form of a reversed cone: the superior convex. Neither hinge nor cartilage.

These fossils agree with the shells of the preceding genus in the absence of hinge and cartilage, but differ essentially in their figure. Bruguiere had united them in one genus, but Lamarck made the warrantable separation. These fossils were first noticed by M. Picot de la Peyrouse, *Description d' Orthoceratites, &c.* who considered them as a particular species of oysters. Plate XVI. Fig. 1, represents one of these fossils, as engraved in the work of Picot, Tab. 12, Fig. 4.

These fossils were obtained from that part of the Pyrenees which is named *Les Corbieres*, and chiefly from that part which extends from Monferrand to Sougragne.

CXXXIII. *Chama.* An inequivalved, adhering bivalve, with unequal incurvated beaks. The hinge with one thick, oblique, and sometimes crenated tooth. Two muscular impressions.

Bruguiere, properly limiting this genus to those shells possessing one hinge-tooth; those shells in whose hinge were two or three teeth, and which used to be placed under this genus, are now disposed under *Cardita*, *Tridacna*, *Hippopus*, and *Isocardia*.

The fossil chamæ of the neighbourhood of Paris appear to correspond

exactly with those of Hampshire. *Chama lamellosa,* of Lamarck, is evidently the same shell as *chama squamosa,* of Brander, *Foss. Hant.* No. 86. *Chama calcarata* of Lamarck, with distant transverse plicæ, the superior of which is echinated with long canaliculated spines, he says, may perhaps be the same with the chama, No. 87, of Brander. Plate XIV. Fig. 13, represents one of these species which I possess, from Grignon.

Lamarck observes, that Bruguiere was acquainted with *C. lamellosa,* and that it is that which he speaks of under the name of *C. rugosa;* but that he confounds it with a chama which is not fossil, and which is figured in Lister and in Gualtieri.

It is, however, probable that Lamarck is here mistaken. I find, among my chamæ, one which certainly shows that there exists a fossil chama, to which the name *C. rugosa* is perfectly applicable. I also find one, which I believe to be fossil, and which exactly agrees with the recent shell figured by Lister, Tab. 217, Fig. 53, which has been considered as *C. foliacea* by Gmelin, and, perhaps, as *C. rugosa* by Bosc.

It is to the kind communication of Robert Scammell, Esq. of Plymouth, that I am indebted for an account of a stratum of fossil shells which he discovered at Haldon, or Hall-down, in the county of Devon. Haldon is a hill, very nearly 850 feet above the level of the sea, and is, from its northern to its southern point, about six miles in length, and nearly three in breadth.

On the sides and summit of the hill, along with the vegetable mould are numerous flints: beneath these is, in some parts, a yellow, and in others a white clay, with a mixture of sand and silicious pebbles of various sizes, to the depth of three or four feet. In some parts is found a light brown sand, which, at the depth of about four fathoms, becomes a firm concretion. The substratum of Haldon is, in some places, chalk, and in others an extensive range of lime-stone.

These strata terminate in others of various formation. Towards the river Ex, they unite with a long range of amygdaloid: they descend into the schist of Ashton; which is here, as in many other

instances, succeeded by granite. In another direction, they are lost in the lime-stone rocks of Chudleigh.

The stratum of shells, Mr. Scammell observes, exists in a stratum of greenish yellow sand, about five feet below the surface; and he is able, from repeated and careful observation, to state that these fossil shells extend upwards of four miles.

The shells, from their extreme brittleness, are almost all in small fragments. Mr. Scammell having, however, kindly furnished me with some of the largest, I was enabled to ascertain that they were the remains of several species of Pectens, of a small oblong oyster, and of a shell, in which, although the characters of a chama were predominant, only one mark of attachment was discoverable.

The general form of this shell is very much like that of the chamæ we have been just describing; the outer surface is pretty smooth, being only marked by faint transverse striæ. The hinge is formed by an oblique, moderately sized, and slightly crenulated tooth, on the flat valve, which is received by an oblique groove, with corresponding crenulæ on the convex valve.

CXXXIV. *Spondylus.* A rough, slightly-eared, inequivalved bivalve, with unequal beaks; the inferior more produced, truncated upwards, and with one groove. The hinge with two thick recurved teeth, with an intermediate pit for the reception of the cartilage. One muscular impression.

Lamarck describes only one species, *S. radula*, as found in the environs of Paris. A fossil shell of this genus, which, from the appearance of its matrix, I suspect to be from Worcestershire, agrees, except in its size being one third larger than the French fossil, with the species described by Lamarck. It is slightly eared, and the inferior valve is marked with rough longitudinal striæ. It is rough, oblique, and of an oval orbicular form. The stronger and most raised of the striæ of the lower valve have small spinous squamæ placed at about half an inch distant; these striæ being separated by from six to nine small granular striæ.

Very fine fossils of this genus are found in Tuscany: an upper valve of one of these, which I possess, and which is in very good preservation, is nearly five inches in length, and four inches in breadth.

CXXXV. *Plicatula.* An inequivalved shell, not eared, with unequal beaks, and having the margins plicated: the hinge formed by two strong teeth on each valve, and an intermediate pit for the cartilage: one mark of attachment in each valve.

This genus is formed from *Spondylus plicatus*, Linn. figured by Lister, *Conch. Hist.* Tab. 210, Fig. 44. The shells of this genus are not, I believe, known fossil.

CXXXVI. *Gryphæa.* An inequivalved bivalve; the lower valve concave, terminated by a beak, and curving upwards and inwards; the upper valve much smaller, like an operculum; the hinge toothless, the pit oblong and arched: one impression in each valve.

Linnæus was induced, from the curved beak of this shell, to place it among the anomiæ, as *Anomia gryphus.* Bruguiere disposed it under the genus *Ostrea;* but Lamarck considered the termination of the beak of the under valve sufficient to allow of its being placed under a distinct genus. He notices nine different species; among which is *Gryphæa angulata*, an individual shell of which, in a recent state, is at Paris.

Fossil shells of this genus are found in considerable numbers in different parts of England, particularly in Oxfordshire, Gloucestershire, Bedfordshire, Wiltshire, Nottinghamshire, and Warwickshire.

Plate XV. Fig. 3, represents one of these fossils from the banks of the Severn, not far distant from Framilode, in Gloucestershire. In this specimen, which is of the most common species found in this island, the rugæ of the lower valve are exceedingly numerous, and consequently arranged very closely together. In the fossil shells of this genus, found in Warwickshire, a considerable difference is observable: the general surface is much smoother; which, indeed, may have proceeded from their having suffered by bowldering. But, besides this circumstance,

another is observable: at nearly equal distances, four or five rugæ are disposed, as if the consequence of different periods of growth.

On viewing the different specimens of ostracites and gryphites, in my collection, I cannot help doubting as to the propriety of the formation of a distinct genus for this shell. I there find specimens in which the beak and the body of the valve possess various degrees of curvature, in a series of gradation, from the complete curve of the gryphites to the slight turn of the edible oyster.

CXXXVII. *Ostrea.* A rough adherent inequivalved bivalve; the hinge without a tooth. The pit of the hinge increasing with age, in the larger valve. The cartilage, half internal. One muscular impression.

The genus *Ostrea*, of Linnæus, was doubtlessly much confused, he having introduced it in several shells, which, like the Pectens, had a full claim to a distinct genus. Bruguiere very properly separated from this genus the genera *Pecten* and *Perna*, and introduced into it several shells really belonging to this genus, but which had been placed by Linnæus in the genus *Mytilus*. Lamarck proceeded still further, and seems to have reduced this genus within its proper limits, by withdrawing from it those shells with which he has constituted the genera *Vulsella* and *Gryphea*.

Lamarck describes eighteen species of this genus, as found fossil in the environs of Paris: *O. bellovacina*, *O. hippopus*, *O. deltoidea*, *O. biauriculata*, *O. vesicularis*, *O. pseudo-chama*, *O. linguatula*, *O. Cochlearia*, *O. longirostris*, *O. canalis*, *O. crenulata*, *O. cyathula*, *O. spathulata*, *O. deformis*, *O. uncinata*, *O. flabellula*, *O. cymbula*, *O. pectinata*.

Several species of this genus are also found in different parts of the continent, as well as of this island.

The most extraordinary shell of this genus, for size, is the large fossil oyster, the recent analogue of which, from Virginia, appears to be depicted by Lister, *Hist. Conch.* Pl. 200, Fig. 34, and Pl. 201, Fig. 35. It is chiefly found at Heutlingen and Aristorf, in Switzerland. The shell of this oyster is sometimes from two inches to two inches and a half in

thickness; and, of necessity, of a considerable weight: the cavity which had been left for the dwelling of the animal being, in proportion, but small. The shells appear evidently to be formed of laminæ, so placed on each other, that their several projecting edges terminate with much irregularity, and give a considerable degree of asperity to their external surfaces. Their size varies considerably; some being hardly five inches in length, and about an inch and a half in width: whilst others attain to the length of twenty inches.

In the mountain of Heutlingen there existed a considerable stratum of these fossils, the uppermost of which had both their valves united; but these were in so fragile a state, that very few indeed could be removed. An under valve which I possess, which is more than thirteen inches in length, and three in thickness, weighs four pounds. To this species may be perhaps referred, *O. canalis* of Lamarck.

The broad flat oyster, from Shotover Hill, Oxfordshire, is a very remarkable fossil. It differs in its form, even admitting that it may have suffered some degree of compression, from any oyster, recent or fossil, which has been hitherto described.

Both valves are equally flat; their form subtrigonal, but very irregular. The external surface is smooth, with the exception of the fine transverse striæ resulting from theterminations of the different laminæ, which do not prevent its resembling a plate of roofing slate. On the internal surface, the very shallow cavity for the oyster, the muscular impression, and the broad pit of the hinge, are very accurately preserved. They differ considerably in size, having been found from two to more than six inches in diameter.

I am happy in being able to place before you an account of the situation in which these fossils were found, about forty years ago, as given in a letter from that assiduous inquirer in this department of natural history, Mr. Joshua Platt, of Oxford, to Mr. Strange.

The depth of the pit, from the surface to stone, is about twenty-seven feet.

1 foot, Vegetable earth.
2 feet, Brown loamy earth, containing spines and plates of echini.
11 ..... Strong blue clay, with no animal remains, except a few of echini.
$1\frac{1}{2}$ ..... Bed of large white lime-stone nodules, in the upper part, containing anomiæ striatæ, cockscomb oysters, auriculariæ plotii (gryphites), and small ammonites.
12 .... Blue clay, of an unctuous feel, which terminates on the bed of stone.

Mr. Platt says, "In this clay, about four feet above the stone, lie the broad flat oyster, with some belemnites and vertebræ of fishes. I was present at the falling of more than a hundred tons of this clay, by undermining it at the surface of the stone; and was much entertained by seeing the pretty appearance which the broad oysters made in their number and different sizes, all lying horizontally: some as broad as my two hands, others small as a shilling."

O. deltoidea, of Lamarck, possesses those characteristics which mark the Shotover Hill oyster—flat, like a placuna; a deltoidal form; cartilaginal pit shallow, oblique, conical, and transversely striated; and transverse irregular striæ on the edges of the valves, on each side of the pit.

At Woolwich, in the pyritous clay, among the cyclades and cerithia, already mentioned, oysters are frequently found; but from the great changes they have sustained, and from their extreme brittleness, I am unable to speak with any precision as to their specific differences. They, however, appear to be of two species: one, long and narrow; about four inches in length, and about an inch in width; and the other semiglobose, and of about three inches diameter. But all the specimens which I have seen, of this, as well, indeed of the other species, appear to have lost their external laminæ, and with them, of course, an important distinguishing character, that of their external surface.

In the adjoining parish of Plumstead, however, and at little more than a mile distance, among the same species of cyclades and cerithia, is

found an oyster, which, in its general form, bears a considerable resemblance to the round oysters of Woolwich. But here, though extremely brittle, the surface of the shell is well preserved; the matrix being a fine white sand, intermixed with round pebbles. The specimens which are here obtained, appear to be a variety of *O. edulis*, somewhat resembling our celebrated *Milton oysters*, in the delicacy of the shell and the regularity in which the rugæ are disposed: the larger shells manifesting a similar approach to globosity of form toward the base of the shell. At Sundridge Park, near Bromley, the delightful seat of Claude Scott, Esq. about five miles to the South-west of Woolwich, is another astonishing quarry of oysters, my examination of which was aided by every possible attention on the part of the polite and liberal possessor. This stratum has been dug into, about the depth of eighteen feet, and is formed of the same species of cyclades, cerithia, and oysters, which I had before seen at Plumstead and at Woolwich. But here the matrix, as well as the matter which filled the hollows of the shells, is of a stony hardness, as if from an impregnation with a dissolved carbonate of lime. Many of the shells have their valves still united, and are filled with stone; and many also are still attached, by the globose part of their under valves, to large round pebbles. Some of these oysters are about three inches and a half in length; but many of them, like those of Plumstead, are much smaller.

So strong is the degree of coherence in this curious mass, that very large entire blocks may be separated. The tasteful possessor of this charming spot has very ingeniously availed himself of this circumstance, by employing this stone, for various ornamental purposes, about his grounds. From the ruggedness of the stone, it exceeds every other substance in composing an imitative ruin. In one part of the grounds walls are therefore constructed with it, on which various exotics are allowed to wildly spread themselves; and in others, arches and alcoves are entirely formed of irregular masses of it; so skilfully, though apparently so negligently disposed, as to have every good and illus-

trative specimen, in such a situation as shall best allow of its examination.

We have thus seen the same roundish oyster at Plumstead, Woolwich, and Bromley; but I was not able to find, either at Plumstead or at Bromley, the long oyster, the remains of which were discoverable at Woolwich. On Bexley Heath, however, about three miles from Woolwich, in a south-east direction, a species of oyster is found, at two or three feet beneath the surface, in the mould, which seems to be similar with that of Woolwich; and is, at the same time, in a much better state of preservation.

The Bexley oyster is from two to three inches in length, and from one to one and a half in breadth. The outer surface is rough. The impression is rather large; and the cartilaginal pit, which is finely striated in a transverse direction, is formed on a vaulted surface of half or three quarters of an inch in length, beneath which vaulted surface a part of the animal must have been disposed.

The shell, which seems, more than all others, to deserve to be termed *O. fornicata*, is one which, from the appearance of the adherent matrix, I suspect to have been found on the Hampshire coast. It is about two inches in length, and one and a half in breadth. Its outer surface is pretty smooth. On its inner surface the margin is seen finely striated, concentrically, by the added lamellæ of growth. The mark of adhesion is about the middle of the shell, and there is no appearance of any pit. But the circumstance most interesting, in this shell, is a vaulted floor, sunk rather more than the eighth of an inch below the margin, and extending from the beak to the middle of the shell. A part of the animal must, of course, have existed beneath this floor, as the mark of adhesion is formed just beneath its edge.

I have a single valve of an oyster-shell, from Carshalton, which is about four or five miles south-west of Bromley; but this valve is larger, longer, and flatter, than those belonging to the shells already described. The Carshalton oyster seems to approach much nearer to the form of the

fossil oysters found near Reading, in Berkshire, being about four inches and a half in length, and about two and a half in width.

Dr. James Brewer, in the Philosophical Transactions for the year 1700, relates the following particulars respecting the bed of oyster-shells found under ground, near Reading, in Berkshire:—"The circumference where these oister-shells have been digged up and found, contains between five and six acres of ground. The foundation of these oister-shells is a hard rocky chalk, and above this chalk the oister-shells lie in a bed of green sand, upon a level, through the whole circumference, as nigh as can possibly be judged; this stratum of green sand and oister-shells is (as I measured) nigh two foot deep. Now immediately above this layre or stratum of green sand and shells, is a bed of a bluish sort of clay, very hard, brittle, and rugged: they call it a pinny clay, and is of no use. This bed or layre of clay, I found to be nigh a yard deep; and, immediately above it, is a stratum of fuller's earth, which is nigh two foot and a half deep—(this earth is often made use of by our clothiers)—and above this earth is a bed or layre, of a clear fine white sand, without the least mixture of any earth, clay, &c. which is nigh seven foot deep: then immediately above this is a stiff red clay (which is the uppermost stratum), of which we make our tiles. The depth of this can't be conveniently taken; it being so high a hill, on the top of which hath been and is dug a little common earth about two foot deep, and immediately under appears this red clay." The doctor dug out several whole oysters, with both their valves, but found them very brittle.

I have only to observe on these oysters, that they appear to be a variety of *O. edulis;* and that, from their long continuance in a subterranean situation, without any lapidifying impregnation, they have become so extremely friable, as to render it very difficult to obtain or preserve a good specimen.

I have found, among the Essex fossils, besides one very much resembling the Bexley oyster, three other species. The one Plate XIV.

Fig. 3, seems to agree with *O. deformis*, of Lamarck. Its irregular and deformed figure is not capable of being described. It is from one to two inches in length, and half as broad. The under valve is much more ventricose than the upper.

The oyster, the lower valve of which is represented Plate XIV. Fig. 5, is very remarkable. It is rather more than an inch and a quarter in length, and nearly an inch in breadth. Its base is transversely extended and truncated, so as to form a straight line: the cartilaginal pit, which is trigonal and very obliquely disposed, somewhat resembles that of a Pecten: at the same time, that an obtuse, tooth-like ridge, lying obliquely across the hinge-pit, gives it much of the appearance of a Chama. This shell very much accords with *O. biauriculata*, Lam.

The fossil oyster represented Plate XIV. Fig. 16, is highly interesting. This minute shell, of which I possess two valves, one only of which is perfect at the hinge, is from Verona. It but little exceeds half an inch in length, and three-eighths of an inch in width. The cartilaginal pit extends high up into the shell, and is very finely striated. The circumstance which most particularly claims attention in this curious little fossil, is, that its thickness is nearly a third of its length, and that its substance is composed of a striated spar, the columnar crystals forming which are disposed perpendicularly to the plane of the shell. Other instances of this striated structure, in fossil shells, have been already shown.

A fossil oyster before me, from the neighbourhood of Maidstone, in Kent, is remarkable for the great depth of its under valve, which is nearlyas deep as the shell is long; being two inches in depth, and only three in length.

Having now placed before you such of the fossil oysters, with either a smooth or irregularly rough surface, as appeared to me to be the most interesting, I shall now call your attention to those fossil oysters, the surfaces of which are regularly plicated. These I shall divide into, 1st, those which have somewhat of a roundish form, and in which the plicæ radiate from the beak to the circumference of the shell; and, 2dly,

those which are of an elongated form, and have a groove or line running along the disk of the valve, from which the folds part on each side, like the teeth of a comb.

Under the first of these sub-divisions may be placed *O. diluviana*, Linn. which is a shell as large, and even larger, than the common oyster, being plicated, and having the margin formed by acute-angled teeth, like those of a saw, and placed at right angles with the surface of the shell: the margin being finely striated by the apposition of the different lamellæ. A small specimen of this species is represented Plate XV. Fig. 1. Shells very nearly, if not exactly, agreeing with these fossils, have lately been found in the South Sea. *O. crista galli*, the fossil cockscomb oyster, appears to be of this same species. *O. flabellula*, Lam. is oblong, cuneiform, slightly bent, with long rough plicæ: the upper valves flat. This shell much resembles *Chama plicata altera*, Brand. and there also exists a considerable agreement in the hinge; for, on a superficial view, the hinge of this shell would be supposed to be that of a *Chama:* the cartilage pit is very oblique and deeply sunk, giving much of the appearance of the receptacle of the oblique tooth of the *Chama.*

The shells of the second subdivision have very much the appearance of a leaf. Such is the fossil oyster from France, Plate XV. Fig. 4, in which the shell, although now perfect stone, retains its original surface and shelly lustre. This species, *O. frons vel folium*, is known to the continental oryctologists as *La feuille de laurier.*

Plate XV. Fig. 2, is a beautiful and rare French fossil of this subdivision, they being hardly ever found in so perfect a state. This shell is also known as a *Crete du Coque*, or *crista galli;* and it must, perhaps, be admitted, that this appellation applies better to its form than to that of any of the preceding shells. This specimen enables us to form a true notion of the shape of the shell, which has not yet been correctly shown.

LETTER XV.

VULSELLA.......MALLEUS.......AVICULA........PERNA........CRENATULA.......
PLACUNA.....HARPAX......PECTEN......LIMA......PEDUM......PANDORA.....
CORBULA......ANOMIA......CRANIA......TEREBRATULA......CALCEOLA.....
HYALÆA.....ORBICULA......LINGULA......BALANUS......TUBICINELLA.....
CORONULA......ANATIFA.

CXXXVIII. *Vulsella.* A free, longitudinal, nearly equivalved shell, with a flattish callous hinge, without teeth, projecting alike on each valve; and a conical rounded pit for the ligament, terminating in a very short bent beak.

This genus is formed by Lamarck for the reception of *Mya vulsella*, Linn; *Vulsella lingulata*, Lam. *Rumph. Mus.* Tab. 46, Fig. A. It is not, I believe, known fossil.

CXXXIX. *Malleus.* A free shell, a little gaping near the beaks, fixing itself by a byssus, and having its valves of the same size. The hinge without a tooth, rather projecting, and supplied with a pit for the cartilage, placed obliquely on the edge of each valve, and separated by the opening which gives a passage for the byssus.

I am not certain of this shell having been found fossil, although, I think, I have seen impressions of it in lime-stone.

CXL. *Avicula.* A free shell, a little gaping near the beaks, fixing itself by a byssus, and having its valves of unequal size; the hinge without a tooth, and rather callous. The cartilaginous pit oblong, marginal, and parallel to the edge by which it is sustained.

This genus receives *Mytilus hirundo*, Linn. of which I do not know of any having been found fossil.

CXLI. *Perna.* A flat irregular bivalve; the hinge formed of many parallel linear teeth, not articulating, arranged on a transverse straight line.

In this genus, formed by Bruguiere, are placed *Ostrea perna*, *O. isogona*, *O. ephippium*, *O. picta*, and *O. legumen*, Linn. Here are likewise placed, by Bruguiere, two fossil shells found on the borders of the Rhine.

Not having the opportunity of seeing the work in which those fossil shells are delineated, *Berl. Naturf.* No. 11, Tab. 9, Fig. 9, I am unable to judge how far they agree with the following shell, which appears to belong to this genus. This shell is figured by M. Walch, Tome II. Pl. D. V. The substance of the shell, which is very thick, is formed of innumerable thin plates, which are exceedingly brittle, but still possessing a considerable portion of the original colour and brilliancy of the nacre. The hinge, which is nearly as wide as the shell itself, is flat, and formed by numerous longitudinal and parallel grooves.

This shell was first found on the mountain Del Sappo, near Bologna, by Monti; and, since then, a stratum of similar shells has been found in the mountain Audona, in Piedmont, by M. Allion. A representation of this fossil is given Plate XV. Fig. 8, from a specimen which I obtained from Mr. Strange's collection. From a more perfect shell, which was in the Leverian Museum, I conclude that the valve in this fossil has lost about half its length.

Lamarck, who, we have seen, has followed Bruguiere in separating several new genera from the genus *Ostrea* of Linnæus, has added the following new genus, formed from recent shells lately discovered in the Red Sea and in the Antilles.

CXLII. *Crenatula.* An irregularly-formed flat bivalve; closed, not giving passage to any byssus; the hinge linear, excavated and crenulated by a row of small pits, which receive the ligament.

In the preceding genus, *Perna*, of Bruguiere, to which this genus approaches the nearest, the hinge is also linear; but it is formed of long parallel grooves, which receive the ligament, and which have between them parallel linear teeth, which shut against each other. But in *Crenatula*, the hinge shows a row of roundish or oval pits, by which it is made to appear as if crenulated; and there are no linear teeth in the interstices.

Lamarck is acquainted with only two species of this genus: *C. avicularis*, brought from the Antilles by Captain Baudin; and *C. mytiloides*, which is formed much like a *mytilus*, and which was found in the Red Sea. *Ostrea picta*, Gmelin, he conceives, may perhaps be a variety of this last shell.

There are very few among the fossil shells of this, or of any other country, which, at first sight, are more dissimilar from any of the recent shells, than the fossil represented Plate XV. Fig. 5. This fossil was obtained by Mr. Strange, from Mr. Joshua Platt, of Oxford, who described it on an accompanying ticket—"Impression of an oyster, with an indented cardo, out of a large nodule on the top of Shotover Hill."

By some it has been considered as an *Ostracite*, by others as a *Pernite;* but neither by its general form, nor by any of its characters, could its proper place be determined. The hinge had often been the subject of my examination; but the result was never any thing more, than that it differed very materially from that of any genus with which I was acquainted. The only information which any author yielded me respecting it, was a very correct figure of a similar cast, by Lister, among the fossil shells of that author, and marked as English, *Hist. Conch.* Tab. 477, Fig. 34, *b*.

A comparison of the hinge of this fossil with that which characterizes this genus, immediately evinced their perfect agreement; and showed that two species are to be found, in very distant parts of the world, of the same genus with this fossil, nothing analogous to which had been till now discovered.

I have very lately been so fortunate as to obtain another fossil of this species: it very nearly resembles, in its form, the fossil which is here figured; but is rather larger, and is invested with its shell.

Mr. H. H. Goodhall, of the East-India House, whose kind assistance I have had repeated occasion to acknowledge, favoured me with the valve of a small shell, which he picked up in a marle-pit near Shefford, in Bedfordshire. The upper and under side of this valve is represented Plate XV. Fig. 6 and 7. It is undoubtedly of this genus, and apparently a different species from the fossil, or from either of the recent shells.

CXLIII. *Placuna.* An irregular, free, flat bivalve: the internal hinge formed by two diverging ridges, in the form of a V, and serving for the attachment of the ligament.

The shells of this genus were placed by Linnæus in the genus *Anomia*, from the shells of which they differ in almost every respect. They are generally flat and rounded, or nearly quadrangular, thin, fragile, demi-transparent, and shining. The superior valve is larger and more tumid than the inferior. The shells described by Linnæus, which may be placed under this genus, are *Anomia placenta* and *A. sella;* but Bruguiere has figured six species. I am not acquainted with any British fossil of this genus.

CXLIV. *Harpax.* An adherent, oblong, and somewhat triangular, inequivalved shell; the hinge formed by two long, diverging, crenulated teeth in one valve, and four in the opposite, disposed in the form of a V: the upper valve, armed with pointed hooks: one mark of attachment.

The only shells of this genus that I have seen, I found about three feet below the surface at Leonard Stanley, in Gloucestershire. These shells are of an oblong, and somewhat of a triangular form. The one valve, which is convex, is rugously plicated, and divided by slight, transverse, curved ridges; and the other, which is flat and thicker, is beset with long pointed and hooked processes, lying longitudinally in transverse rows. The hinge is formed by two long projecting teeth, transversely crenulated on both sides, and diverging in the form of a V. on

the flat valve; and by four diverging raised teeth on the convex valve; the latter being so disposed, and so crenulated on their inner surfaces, as exactly to receive, as in the *Trigonia*, the teeth of the opposite valve.

Aware of the danger of unnecessarily multiplying genera, I was at first disposed to consider this shell as a species of *Trigonia:* from this, however, I was precluded, on discovering that, unlike the shells of that genus, these were adherent—a difference, undoubtedly, sufficient to prevent their being disposed under the same genus.

Plate XII. Fig. 14, represents the internal surface of the flat valve; and Fig. 16, a magnified view of its hinge-teeth. Fig. 15 is the internal surface of the convex valve, and Fig. 17 a magnified view of its hinge-teeth. Fig. 18 is a magnified view of the outside of the flat valve, showing those strong hooked instruments, from which it has presumed to give a name to the genus. One specimen of the upper valve of this shell manifests a very considerable degree of lustre.

CXLV. *Pecten.* A regular, eared, inequivalved bivalve, with contiguous beaks. The hinge toothless, the pit trigonal, receiving the internal ligament. One muscular impression.

Of those which are in my collection, I much regret the being totally uninformed of the locality of most of them. This I particularly regret being the case with a specimen which has been imbedded in a hard whitish lime-stone, and which is in every respect analogous with *P. jacobeus*, *List. Conch.* 165, *f.* 2, 166, *f.* 3, having, on the lower valve, fourteen angulated rays, longitudinally striated: the sulci transversely striated: the upper valve having the rays rounded and striated transversely. Thus is it also with a most perfect specimen of *P. radula* and *P. varius*, differing in no respect from *O. radula* and *O. varia*, Linn, except in each being of a small size.

Lamarck particularizes three species found in the neighbourhood of Paris: *P. plebeius*, *P. infumatus*, *P. squamula.* In the Harwich cliff are specimens found, which I think are referable to the two former of these species.

A very beautiful Pecten is found in the green sand of Wiltshire, of which a very correct representation is given by Lister, *Conch.* Tab. 470, Fig. 28.

It is an equivalved, slightly orbicular shell, both valves being rounded: it is ornamented with about seventy-two roundish radii, which are muricated with tubular squamæ; twenty-four larger radii, having two or more smaller radii disposed on each side. In some specimens, and particularly in the superior part of the shell, the intervening smaller radii are more numerous. The ears are marked with oblique, curved rugæ. The beauty of this fossil, derived from the richness of its ornamented surface, is not all that renders it interesting: the substance of which it is formed cannot fail to excite a considerable degree of admiration. It is completely silicious, and even in some parts transparent; and yet the minutest parts of its markings do not appear to have suffered any alteration in their form from this change.

One of the most interesting fossils of this genus, which I possess, is the greater part of a fragment of an upper valve, with angulated ribs, imbedded on chert; and which, although so changed as to be now highly silicious, still retains a considerable portion of its original colour.

A singular Pecten is found near to Thame, in Oxfordshire, imbedded, as I have been kindly informed by Mr. Lupton, of Thame, in a green silicious sand, resting on an indurated clay, at nearly sixteen feet from the surface. This is an auriculated shell, about three inches in diameter, and nearly circular: both valves are marked with regular, transverse, concentric, imbricating ridges, and both convex; but the upper one less so than the lower. A Pecten, of half the size of the preceding, with much stronger concentric ridges, is found in the valley of Ronca.

In Gloucestershire is frequently found a Pecten, which in many specimens, has attained a considerable size, six or seven inches in diameter. These shells, at least the specimens which I possess, have twenty-four nearly smooth roundish radii, with very faint transverse lines of growth running over them and the intervening sulci. The ears appear to be

marked with very fine and light longitudinal striæ. In the specimen before me, both valves are alike gibbous: the shell is consequently equivalved, and therefore seems to point out the necessity either of altering the terms in the definition of this genus, or of forming another genus, to comprize those shells which, possessing the other characters of Pectens, are not formed of unequal valves. There is no separation at the hinge, nor at the sides of this shell, and consequently it cannot be referred to the following genus.

CXLVI. *Lima.* A longitudinal, nearly equivalved, eared bivalve, with the beaks separated by a cavity. The hinge toothless. The hinge-pit, which receives the ligament, partly internal and partly external.

These shells are removed from the preceding genus, or rather from that of Ostrea, by Lamarck, who considers their separation authorized by the similarity between each valve, and by the ligament being in a great part external. *Ostrea lima,* Linn. is referred by him to this genus, as *L. squamosa.* Hither he also refers *Ostrea bullata,* and five other supposed *Ostreæ,* figured by Chemnitz, Tom. VII. Fig. 649, 650, 652, 653, 654. He also describes five fossil species found in the neighbourhood of Paris: *L. spathulata, L. bulloides, L. obliqua, L. dilatata, L. fragilis.*

I find, among my fossils, none which I can positively assign to this genus. Those which, I think, may be referred hither, are silicious specimens from Wiltshire, in the neighbourhood of Tilsbury, which are injured in their lower side, and consequently do not show the hinge.

CXLVII. *Pedum.* An eared, inequivalved bivalve, gaping at the lower valve, and having its beaks separated; the hinge toothless, the ligament exterior, and fixed in a long and narrow groove; the inferior valve notched.

Of the shell for which this genus was formed by Bruguiere, and which has been figured by Favanne, Tab. 80, Fig. K.; by Chemnitz, T. 8, Tab. 72, Fig. 669 and 670, and by Bosc. P. x. Fig. 3 and 4, but little is known. This shell has not, I believe, been found fossil.

CXLVIII. *Pandora.* A regular, inequivalved, and inequilateral

bivalve, with two oblong, unequal, and diverging hinge teeth, in the superior valve, and two oblong corresponding pits in the other valve: the cartilage interior, and two muscular impressions.

This shell is thin, and semi-transparent, the dorsal suture straight, prolonging and widening itself at one end. One valve is convex, and the other flat. The inequality of the valves separates this shell from the Tellens. *Tellina inequivalvis,* Linn. is referred to this genus, of which no fossil shell has been mentioned.

CXLIX. *Corbula.* A subtransverse, inequilateral, inequivalved bivalve, with rather prominent and incurvated beaks: a single conical recurved hinge-tooth in each valve; the cartilage internal; two lateral impressions.

This is exceedingly distinct from every known genus. The beaks of these shells are particularly tumid and curved inwards, and one of their sides is much more lengthened and thin than the other. Lamarck refers the shells Vol. x. Tab. 172, No. 1668 to 1671, in Chemnitz's work, to this genus. He also describes eight fossil species found in the environs of Paris: *C. gallica, C. rugosa, C. striata, C. angulata, C. anatina, C. argentea,* and *C. cancellata.*

C. gallica is the largest of these, and that in which the characters of the genus are most decidedly shown: it is generally about an inch and a half wide. M. Lamarck observes, of this shell, that it is transverse, oval, tumid, and very singular, from the lower valve being smooth, and having its hinge-tooth originate beneath the edge, and curve up towards the beak; whilst, in the upper valve, longitudinal striæ are evident, and the tooth proceeds from the edge of the valve, is compressed, and stands up perpendicular. It is not, however, certain whether these may not be valves of distinct species, since they have always been found separated.

Plate XVI. Fig. 2, represents the inside of the smooth valve of *C. gallica,* in which may be perceived the hinge-tooth, approximating to the beak.

In the Devonshire whetstone-pits, a shell is found, measuring from three to five inches in width; and which, I suspect, from the particular oblique turn of its beak, and from so much of the hinge as I have been able to expose, belongs to this genus. This shell is very unequal sided, and the upper part of its produced side has been set with minute spines, regularly disposed.

CL. *Anomia.* An irregular shell, with unequal valves; the inferior valve pierced or notched at its beak, which is sometimes closed by a little operculum, or third valve, attached to a cartilage passing out of the hole or notch, and serving to fix the animal on other bodies. The hinge without teeth.

With the shells of the genus *Anomia*, as formed by Linnæus, Bruguiere and Lamarck have composed six genera: *Anomia*, ***Placuna***, *Crania*, ***Terebratula***, *Calceola*, and ***Hyalæa***.

The shells of the present genus differ from others chiefly in possessing a valve or operculum, with which the animal fixes itself to adjacent bodies. This circumstance, it is to be observed, can only be ascertained in the recent shell; and therefore cannot be called into aid, when comparing the fossil shells of this genus with those of *Terebratula;* since, each having an opening in the under valve, there exists no particular difference in that state; excepting, that the shells of the genus *Anomia* are more rude and irregular than those of *Terebratula.* I am therefore unable to point out any fossil shell which shows any proof of having possessed the characteristic valve or operculum of this genus. *Anomia ephippium*, Linn. *List. Conch.* Tab. 204, Fig. 38, is instanced as a species of this genus.

CLI. *Crania.* A regular inequivalved bivalve: the lower valve flat and nearly round, and pierced in its inner face with three unequal and oblique holes; the upper very convex, furnished interiorly with two projecting callosities.

These shells had been ranged among the Anomiæ, and formed the *Anomia craniolaris*, Linn.; but Bruguiere and Lamarck considered

the three holes in the lower valve as sufficient to demand for them a distinct genus. Bruguiere has made out four species, three of which are fossil. Being unacquainted with these fossils, I have, for their illustration, copied the representation of the lower valve of *C. personata*, Lam. *Anomia craniolaris*, Linn. Plate XVI. Fig. 3, from Plate VII. of *Hist. Nat. des Coquilles, par Bosc.*

CLII. *Terebratula.* A regular shell, fixed by a cartilage or short tube, and composed of two unequal valves, the largest of which has its beak produced and pierced with a hole, through which the cartilage passes. The hinge with two teeth.

After having abstracted from the Linnæan genus *Anomia*, the shells forming the genera *Anomia*, *Crania*, *Calceola*, and *Hyalæa*, it was intended, by Lamarck, to place under the present genus *Terebratula*, the remainder of those shells which had been hitherto considered as Anomiæ. But considerable difficulty will be still found to exist, as to the classification of these shells. Mr. Martin, whose accuracy and judgment, displayed in the division of the shells of this genus, might alone suffice to render his work highly valuable, and to make every lover of science regret his loss, has shown that, among these shells, there exist much greater differences than Lamarck is apprized of. He found it necessary, on this account, to arrange them in the four following families :—1. Imperforated, with one valve flat, and with a straight, extended, and narrow hinge. 2. Perforated, both valves convex ; the hinge straight and patulous, with a large trigonal foramen between the beaks : these are subdivided into those with a long or a short hinge. 3. Perforated, both valves convex ; the beak of the larger valve incumbent, with a very small trigonal or oblong foramen : the hinge close and curved. 4. Perforated, both valves convex, the beak of the larger valve pierced by a tubular opening ; the hinge close and curved.

It is evident, that, of these four families, the shells of the two last only can be placed, in strictness, under this genus—the imperforated, and those with a large trigonal foramen between the beaks, cannot be

made to correspond with the description of the genus *Terebratula.* The consideration of the two first of these families we shall therefore defer, for a little, and for the present confine ourselves to the examination of the Terebratulæ only.

In the shells of this genus, a peculiar cartilaginous and bony conformation exists, serving for the attachment of the animal, and which fully warrants their separation from *Crania, Calceola,* &c. : only slight remains of this structure can sometimes be traced in the fossil shells; but in the recent shells it may be seen very distinctly. Plate XVI. Fig. 7, is a representation of this part in a recent shell of this genus, bearing the general form of *A. lacunosa.* It is here seen to arise from four points of the smaller shell, two just under the hinge, and two near to its centre : these, having united by a transverse process, again divide, branch upwards, then turn back, and terminate in a narrow, transverse, and somewhat circular band. In the longer and more oval formed species, having the general figure of *A. terebratula,* Linn. this part is of a somewhat similar shape, but is much smaller, and more delicate, as is represented Fig. 6.

On more particularly examining this part, it will be found still to possess some degree of elasticity; which must, of course, have existed in a greater degree during the life of the animal. But it is obvious that neither this peculiar construction, nor this elastic state of these parts, could have been necessary, merely for the attachment of the animal; and, with the few opportunities which we possess, of examining into the habits and economy of this animal, it is difficult to determine what was the real office in which its powers were employed. Conjecture may, however, be somewhat aided, by attending to the directions in which this spring is calculated to act. If its termination be drawn perpendicularly upwards, as with the opening of the shell, it would, when left to itself, spring downwards; and again, if drawn horizontally towards the beak of the shell, it would gently spring in the contrary direction. Hence it may be supposed, that if, contrary

to what occurs in other shells, the animal employed some muscular action in opening the shell, on this ceasing, this apparatus would immediately assist in bringing the valves together: and if the animal were attached to any substance by one end of its cartilage, which runs through the beak of the shell, whilst the other end might be connected with this apparatus, the resiliency would be increased, and the danger lessened of the cartilage, or of the animal itself being injured by those shocks which it might receive whilst thus suspended.

The following are species of this genus which are not, I believe, generally known.

Terebratulites coarctatus. A nearly heptagonal shell, set with beaded longitudinal ridges: the larger valve sulcated, with its sides appearing as if pinched together, and terminating at the beak with a large foramen; the hinge small, close, and curved; and the smaller valve convex. Plate XVI. Fig. 5.

T. triquetrus. A three-cornered shell: the anterior and posterior sides compressed; the superior margin more rounded, but dented in the middle: both valves convex, and terminating in a point, with a close and curved hinge; the large valve having a narrow groove, commencing in nearly the centre, and extending to an umbilical-formed depression in its lower part, just before the beak turns, and finishes with a round foramen.

Two different specimens, both appearing to belong to this species, are figured Plate XVI. Fig. 4 and 8. In the former, a small portion of the shell still adheres on the lower part of the larger valve, which is here shown uppermost; but the latter specimen, which is here shown with the smaller valve uppermost, has none of the shell remaining. The substance of these fossils is a very fine close-grained lime-stone. I am unacquainted with the habitats of these, or of the former fossil.

The casts of some species of Terebratulæ are of a most extraordinary form, and obtained a considerable degree of attention from the early oryctologists. It appears that these casts were first noticed by

Pliny (*Lib.* XXXVII. *Cap.* 57,) who describes certain stones, some of which were white and others brown; the former bearing in their figures, some resemblance to the male, and the latter to the female, parts of generation. These bodies were next noticed by Agricola, *De Nat. Fossil.* Cap. XI. as having been found whilst digging near the fortress of Ehrenbreitstein, in Treves. After various opinions had been offered respecting the origin and nature of these bodies, Wolfart, *Histor. Natur. Hass. infer.* p. 30, advanced the opinion, that the latter of these fossils were the casts of a peculiar kind of marine shell. This opinion was, however, for a time, opposed by Henckell, who even doubted of their animal origin, but afterwards very candidly acknowledged the force of Wolfart's arguments.

These curiously formed fossils are now known to have derived their figure from the internal structure of shells of this kind: in many of which I perceive a peculiar conformation entering far into the shell, apparently adapted to support the termination of the cartilage which the animal extrudes, and which structure would be a mould, in which a similar body might be cast. The beak of one of these shells, with this particular structure, is shown Plate XVI. Fig. 20.

I will now call your attention to those shells which Mr. Martin found it necessary to place in two families distinct from those which comprise the shells which we have just examined. The first is, that which comprises the imperforated shells, with one valve flat, and a straight, extended, and narrow hinge.

The most extraordinary, perhaps, of the imperforate shells, is *Anomites productus*, of Martin, the larger gibbous valve of which is lengthened out in a cylindric form, and longitudinally striated; the striæ close, equal, and, towards the margin, dichotomous: the margin itself somewhat sinuous and irregular. In many specimens, the upper part, particularly near the beak and hinge, is set with a few distant tubercles; the beak small and pointed. The other valve is small, semicircular,

and concave, clasped or surrounded by the larger valve, and longitudinally and sometimes transversely striated.

Its most striking characteristic is, the lengthened cylindric form of the convex valve. This is always filled with lime-stone, which entirely conceals from observation the other part of the shell, as long as the specimen remains whole. With the slightest blow of a hammer, however, it constantly divides, *where the edge of the smaller valves rests against the inside of the elongated cylindric part of the larger valve*, generally about half an inch or less from the top of the shell; Fig. 9, *a*, one side of the valve, before hidden, then becomes visible, as at Fig. 10.

Thus far is the description of Mr. Martin; but I must here add, that my late worthy friend, Dr. Menish, was strongly of opinion that this was not the whole history of the shell, and that there were reasons for suspecting that this shell was a multivalve. I am not in possession of the particular specimen on which the Doctor rested chiefly the support of his opinion. I will avail myself, however, of the specimen before us, to show that the structure of this shell is not such as has been hitherto supposed. In a bivalve, we have one cavity for the habitation of the animal; but, in this specimen, there appears to be at least two: one between the upper valve, Fig. 9, and the lower valve, Fig. 10; and another above, which is shown by the fracture at Fig. 9, *c*.

I am aware that it may be contended, that I may have been led into a mistake by the lower valve having split; and that the upper half remains attached to the bottom of the upper valve at *a*, Fig. 9, whilst the lower half adheres to the mass Fig. 10, at *b*. But I cannot readily admit this to be the case here; since, at *a*, the incumbent beak of the upper valve is plainly to be seen, and at *b* is the little pit in the lower valve for its reception, both of which could not be seen if the valve had split. It may also be said, that the upper valve might be naturally hollow; but, even if this circumstance be admitted, that will, I hope, be allowed to be an anomaly, worthy of being thus shown. Possessing only this specimen of fellow valves of this shell,

I may have made some mistake, which those who possess more illustrative specimens may be able to correct.

It becomes here necessary to notice the specimen Plate XVI. Fig. 10; since, in this shell, appear to be traces of such a structure, as would serve to show, that the animal, in a multivalve shell of this kind, might not be without the means of supporting a temporary connection, at least, between these supposed cavities.

This shell is imperforate, one valve convex and gibbous, the other concave. The circumference is rounded, and the surface of each valve marked with longitudinal striæ, which are decussated by faint transverse ones. The beak of each valve is small. A little below the beak of the concave valve, a small, but apparently deep fissure, commences, which, in one of the two specimens which I possess, extends in a straight line towards the margin, through nearly three-fourths, and in the other through nearly one half of the length of the valve. This fissure has the appearance of having been larger, and of having been diminished at each end. In one of these specimens, the margin of the shell is entire, and the valves are so exactly closed, as not to admit of any separation being seen, even with a strong magnifier. In the other the margin is broken, and has very much the appearance of the upper valve having been produced.

It must be left to some more successful investigator to pursue this inquiry; in the meanwhile, the conjecture on which we may rest, perhaps, with most propriety, is, that this structure has taken place for the purpose of allowing the passage of some part of the animal, by which it might be enabled to attach itself to other bodies.

The shell whose extraordinary internal structure I shall now call your attention to, must also, I believe, be placed among the imperforate shells, since I have been unable to discover any aperture in the beak or hinge of any of those which I have sacrificed to my inquiries; and since, indeed, in the specimen Plate XVI. Fig. 11, the beaks are too much inverted to have admitted the passage of any tube or cartilage; and I am almost

satisfied, from having cleared away this specimen very close indeed to the beaks, that there was no opening in the hinge between them.

The fossil Plate XVI. Fig. 13, which is a specimen from Mr. Forster's collection, first excited my attention to the peculiar structure to which I have alluded. It is a tubular body, spirally disposed, in the form of a cone, curved at its apex; which is lodged in the remains of a shell, in the angle at the side, where the upper and lower margins united, a part of this tube going off from the base towards the opening of the valves at their upper margin. The tube itself is beautifully frosted over with quartz crystals, and the matrix in which it is imbedded is chert. From two or three casts, and from several impressions in the mass, I was convinced that the shell in which this body was inclosed was of the Linnæan genus *Anomia;* and, reasoning from the proportions of that part of the shell which remained, I was surprised at finding that this body must have filled nearly one half of the shell.

After rubbing down and breaking many different shells without success, I found the same structure, but badly shown, in two shells, one of which was about the size of that in the above specimen. At length, I was so fortunate as to discover traces of it in a larger shell of the same species; and, by breaking away a considerable part of the smaller valve, and of the spathose matter contained in the shell, was enabled to display it as shown Plate XVI. Fig. 11. With respect to the shell itself, like *A. striata* of Martin, it has a hinge straight, extended and patulous, valves convex, semicircular, and longitudinally striated on every side. In the smaller valve is a convex wave, which is answered by a scarcely distinguishable concave one in the larger valve. In a word, were it possessed of a large triangular opening between the beaks, it would then possess all the external characters of that species.

The structure of this particular part seems to point it out as an organ of attachment, and perhaps of motion. Supposing this to have been a strongly elastic cartilaginal tube, and that the animal possessed the power of uncoiling and extending it so as to be able to fix its end to some firm

body, at its utmost length; it would then be only to leave the tube to its own powers, when, by its elasticity, it would coil up to its original form, and drag the shell to the point to which it was attached. I could easily devise other uses for this part, but am unwilling to wander too far into the regions of conjecture.

I must here observe, that as this curious structure filled nearly one half of the shell, I was anxious to discover whether a similar structure existed on the other side; but this side was so completely filled with spar, that after having very much injured the specimen, the fear of destroying it entirely made me desist; not, however, until I had found very great reason for believing that a similar body did not exist on that side, although traces of some kind of organization might here be discerned.

By viewing the long patulous hinge of the shell Plate XVI. Fig. 11, and supposing a large trigonal aperture to exist between the beaks, you obtain a correct idea of the characters of that family of shells which Mr. Martin describes as being perforated, having both valves convex, with a straight open hinge, and a large trigonal foramen between the beaks. But the different species of these shells differ much among themselves, and particularly in the depth of the area belonging to the hinge.

The shell represented Plate XVI. Fig. 17, shows this area, spread out to a surprising extent. This shell was first noticed by Mr. Martin, in the Linnæan Transactions, Vol. IV. p. 4; and, since that, in ***Petrificata Derbiensia***, Plate 46, where he thus describes it:—" A petrified shell. The original an *Anomia*. Perforate. Valves convex. Hinge straight, extended, patulous, triangular, divided down the middle by a very large perpendicular foramen, in form of an acute isoceles. The surface of the shell longitudinally furrowed. The furrows strong, about 28 or 30, crossed by a few distant wrinkles, marking, apparently, the growth of the shell. A deep, rounded sinus, destitute of furrows, in the larger valve: answered by a convex wave on the other valve, and terminated by a strong curvature at the margin. Perforated valve, pyramidal, perpendicular, gradually tapering from the margin to the beak,

which is somewhat reflected and cuspidate; and constitutes, as it were, the apex or summit of the pyramid: the back, or that part of the valve proceeding from the margins, rounded: the opposite side flat, consisting of the hinge and foramen described. The other valve semicircular, moderately convex, broad; its beak prominent, pointed, and incurved over the base of the foramen."

The specimen represented Plate XVI. Fig. 17, differs from that figured by Mr. Martin, only in the beak of the conic valve not being so much reflected. On the upper part of this figure is the semicircular valve, with the convex wave on its back, *a*, terminating forwards in the prominent, pointed beak, incurved over the base of the foramen. On the lower part is the conic valve, which has on its back part, but which could not be here shown, a deep rounded sinus, its base joining the base of the convex wave on the semicircular valve at *a*, and terminating in a point at the bottom, where it meets the point of the perpendicular triangular foramen at *b*, in the apex, or what must rather be considered as a beak, though not so formed.

This ingenious naturalist observed, that the species *A. subconicus* united this species with the more common straight-hinged perforated anomitæ; but added, that in another shell, which he had not yet named or described, the hinge is still less; and the beak of the large valve, instead of being straight, is somewhat incurved, and therefore more strictly united the species. As Mr. Martin's collection is now dispersed, there is little reason to expect that the figure of this shell will be published; it is therefore with pleasure I find myself able to give a representation of a shell which seems to possess all the characters of that of which he has spoken.

This shell, Plate XVI. Fig. 16, is of a roundish trigonal form, with two convex, longitudinally-furrowed, valves; the furrows being rounded. The hinge straight, extended, and very patulous, with a large triangular pit or foramen, between the beaks of the two valves. The beak of the large valve, at the point of the foramen, at *b*, unlike that of the pre-

ceding species, is a little incurved and beak-formed; and its sinus, commencing at this beak, is smooth and rounded, like that *Cuspidatus;* and joins with its base, at the back part, the base of the convex wave of the upper, or smaller valve, at *a*.

I must acknowledge that the term foramen, or aperture, does not seem applicable to the triangular cavity in either of these shells; it appearing to be rather a deep triangular groove, in which might have been fixed a strong muscle or elastic cartilage, the office of which might have been to have drawn open the valves. This, however, is only conjecture. I shall therefore proceed, acknowledging that I have dwelt longer on these two last species, from the expectation that it might lead to the better understanding of the following genus.

CLIII. *Calceola*. A regular inequivalved bivalve: the largest valve being in the shape of the pointed end of a slipper, and the small one flat and semicircular. The hinge with a central tooth, and four rugous projections at each end.

This shell is very thick, and nearly an inch and a half in length. The back of the large valve is flat, and marked with transverse linear striæ, which are continued over the rounded fore part. The upper valve is striated concentrically. Plate XVI. Fig. 14, represents the upper, and Fig. 15, the lower valve of this shell.

It is placed by Gmelin at the end of the genus *Anomia*, as *Anomia sandalium*. To this species, the only one which is known, Lamarck has given the name of *C. sandalina*. It was first discovered in the duchy of Juliers, by M. le Baron de Hüpsch, of Cologne, who gave a particular description of it in a tract published at Francfort, in 1768, under the title of *Nouvelles decouvertes faites dans l'histoire naturelle de la basse Allemagne, des petrifications de quelques animaux testacés rares et peu connus, &c.* M. Hüpsch kindly distributed these fossils among the more intelligent collectors, who were thereby enabled to form their respective opinions of these extraordinary bodies. M. Hüpsch himself was of opinion that it was a fossil, inequivalved, bivalve shell, the smaller

exactly closing up the cavity of the other valve: he also pointed out, on the inner side of the back part of the larger valve, the remains of a hinge formed of teeth with corresponding depressions, with an analogous surface on the posterior edge of the smaller valve.

M. Guettard was of opinion, from the appearance yielded by the inner surface of the larger valve, that it had proceeded from the labours of some zoophyte. M. Walch acknowledges that this opinion derived some support from the appearance of coralline texture; since, on examination with a glass, of the two specimens possessed by him, a very fine texture, formed by intersecting threads, appeared, and which was similar to that which is seen on some of the Maestricht fossils, but which he was unable to determine whether it was accidental or not.

This very curious fossil having very much excited my attention, I was happy in obtaining a very complete specimen, at the sale of the late Mr. Forster's collection, by which I am enabled to place before you an accurate representation of both the valves. Plate XVI. Fig. 15, is the anterior part of the larger valve, in which the superior margin and the hinge part is in good preservation: at *a* is a magnified representation of the tooth in the middle of the posterior margin of this valve.

Plate XVI. Fig. 14, is the internal surface of the flat semicircular valve. To procure a display of the structure of the hinge, in this valve, was exceedingly difficult; but by the alternate employment of the instrument, and of the muriatic acid, this view of it was obtained. It is there seen, that in this hinge there are three parts which are particularly observable: a long beak-formed tooth, in the centre of the posterior margin, answering to the tooth in the posterior margin of the other valve, and a protuberance at each end, formed by four or five alternate ridges and furrows.

The lens discovers the reteporean appearance on the internal surface of the large valve; a part of which, thus magnified, is represented at *b*. From the circumstance of its occurring in both valves, but particularly

from its being exactly confined to the internal surface, I conceive that it belongs to the original structure of the shell.

On clearing the larger valve, a reddish hue became very evident, and appeared to be the remains of the original colour of the shell.

When the straight hinge and box-like form of this shell is considered, some resemblance will appear between it and the fossils which we have just been examining. But a more material coincidence is discoverable in the strong resemblance which exists between the surface of the back of the larger valve and that of the larger valve of the preceding fossil, Plate XVI. Fig. 17, both surfaces being remarkably smooth, and formed by extremely fine transverse striæ.

CLIV. *Hyalæa.* A regular, inequivalved, transparent bivalve shell, gaping beneath the beak, tricuspidated at the base.

This shell was originally described by Forskal, and named by him *Anomia tridentata*, and as such admitted by Gmelin. Lamarck has very properly placed it in a distinct genus. It is not known in a fossil state.

CLV. *Orbicula.* A very small orbicular, flat bivalve. The lower valve very thin, and adherent to other bodies. The hinge unknown.

This shell, only described by Muller, and named by him *Patella anomola*, is not known as a fossil.

CLVI. *Lingula.* A long flat shell, composed of two valves, nearly equal, truncated anteriorly; the hinge without teeth: the base or beak of the valves pointed, and united to a tendinous tube, serving for a ligament of attachment.

Linnæus, who had seen but one valve of this shell, named it *Patella unguis.* Bruguiere ascertained the nature of the shell, and assigned to it this genus. It has not been yet noticed as a fossil.

In consequence of the similarity of the animals which inhabit the shells forming the two following genera, Linnæus disposed them under one genus, which he named *Lepas.* But Bruguiere and Lamarck have, with

propriety, again separated them, and placed them under two distinct genera, *Balanus* and *Anatifa*, agreeable to the differences which the form and structure of their shells seem to point out.

CLVII. *Balanus.* A conical multivalve, fixed by its base, and composed of six articulated valves; the opening being closed by an operculum, formed of four valves.

The Balani are not to be considered among those fossils which are frequently found. Bayer figures a Balanite found in the neighbourhood of Nuremberg. In France, agreeable to D'Argenville, these fossils are of rare occurrence; nor do I believe they are frequently found in this country. They are indeed sometimes found, very small, on the Harwich fossil-shells; and I possess one of these, which is detached, and so small as to be really a proper microscopic object. M. d'Aunone particularly speaks of some of these fossils found in the neighbourhood of Basle, and Monti discovered them in the mountains near Bologna. Targioni also describes those of the hills of Pisa; and M. Allione mentions several specimens found in Piedmont. In the hills of Tuscany they are also found, in very considerable numbers; and even the specimens which are found there are said to contain more species than have yet been observed in a recent state. It is worthy of remark, that many of the Balanites which are found in the arenaceous and calcareous strata of the Tuscan hills, still retain a considerable part of their colour. The specimens which I possess, of this fossil, are from Tuscany, Piedmont, and Maryland; but none of them are in that state of preservation as will allow of ascertaining precisely their specific characters.

Lamarck appears to have very properly separated from the genus Balanus those shells of which he has formed the two following genera, and which are composed of the shells which, with their inhabitants, are found deeply imbedded in the fat of whales.

CLVIII. *Tubicinella.* A regular tubular, not spiral, univalve; narrowing towards the base, and truncated at each end. The terminal opening circular, with a four-valved operculum.

It is doubtful whether there are more than one specimen of this genus. This shell has not, to my knowledge, been found fossil.

CLIX. *Coronula.* A regular subrotund, or subconical shell, divided into twelve areæ, with an opening both in the superior and inferior part; that in the superior part closed by a four-valved operculum.

Of this genus there appears to be three species known, which may be distinguished by the same specific names which distinguished them under the genus *Balanus: C. diadema, C. testudinarius,* and *C. balænaris.*

The shells of these two genera, with their inhabitants, are found deeply imbedded in the fat of the whale, so as to leave only the superior surface uncovered. M. Dufresne, who first gave this information to Lamarck, obtained it upon viewing two specimens, preserved in the collection of Mr. John Hunter, in which several of the genus *Tubicinella*, and of the species *Coronula baleanaris,* were thus fixed in part of a whale. M. Dufresne was led by the knowledge thus obtained, to repair to Greenland Dock, to inquire of persons concerned in the whale-fishery, what they had observed respecting these animals. He was there assured, by a person of the name of Palmer, that he had caught a whale which carried more than two hundred of these animals, arranged in groups of twelve or fifteen families or tribes, on the superior part of the whale. *Ann. du Mus.* I. 170.

Whilst placing before you a representation of a rare and unexpected fossil, *Coronulites diadema*, Plate XVI. Fig. 19, I much regret at not being able to inform you where it was found. A view of the figure will show you its agreement with Gmelin's description of *Lepas diadema*, Linn. which, in the words of Linnæus himself, is, *Testa subrotunda, sex lobata sulcata.* Gmelin says of it: *Habitat —, sordide alba,* $\frac{3}{4}$ *pollicis circiter alta, sursum angustior, apertura superiori infundibiliformi, dimidiam reliquæ testæ diametrum æquante, areis exterius* 12 *triangulis, quarum* 6 *excavatæ striis subtilibus transversis exaratæ, sex alteræ elevatæ* 4-5-6 *prominentiis arcte sibi accumbentibus, et striis transversis crenatis exaratis constant. Syst. Naturæ, p.* 3208.—I know

but of one more specimen, which was in the valuable collection of Mr. Donovan, and exhibited in the London Museum.

CLX. *Anatifa.* A cuneiform multivalve, composed of several unequal valves, five or more, united together at the extremity of a cartilaginous tube, fixed at its base. The opening without an operculum.

This shell is in general composed of five principal valves, to which sometimes several smaller are united by a connecting membrane. These are all supported by a strong cartilago-membranous, flexible tube, which is capable of being elongated or contracted at the will of the animal.

A. lævis and *A. striata* are both said by Bosc, *Hist. des Coquilles*, Tome II. p. 172 and 173, to be found fossil. The latter of these is also said by Gmelin, *System. Nat.* p. 3210, to be sometimes found fossil. Neither of these statements are, I believe, supported by sufficient authority; since all the substances which I find described, as the fossil remains of this animal, appear to be of a different origin.

Some long and narrow fragments have been found on Mount Randen, in Switzerland, one of which is figured by Bourguet, *Traitè des Petrifications*, Pl. LIII. No. 355, as *Petit os d'Echinite;* and others are figured by Knorr, who also supposes that they are the teeth of an echinus. These are supposed by Bertrand, *Dictionnaire des Fossiles*, p. 156, to be the fossil remains of a shell of this species; some of these fossils, which are in my collection, have decidedly the appearance of being echinal remains. Scheuchzer and others have described single valves, which, from their compressed and triangular form, they have been led to imagine were the remains of a shell of this genus. But these are the valves which I have already placed before you, under the genus *Trigonellites*, not seeing any reason for supposing them to belong to the genus *Anatifa*, or, indeed, to any other previously formed genus.

The fossils to which I shall now call your attention are particularly interesting, not merely from the puzzling appearances, which serve, in a considerable degree, to conceal the origin of the fossil to which they belong, but also as they serve to account for the peculiar rugose and stri-

ated form observable on several pebbles. I have very little doubt of these fossils deriving their forms from some lost or unknown species of this genus.

The first specimen of this kind which attracted my notice, is a flint stone which I picked up in the gravel-pits near Hackney-road. This is represented Plate XVI. Fig. 18. The regularity of the transverse striæ on the round trachea-like body which they compose, and the smooth surface of the valve-like body in which they terminate, gave me at first an idea, not only of its having derived its figure from animal organization, but of its affinity to the barnacle.

The opinion which I at first formed, received corroboration from different specimens which I afterwards met with. In some of these specimens, both the shelly valve and the cartilaginous peduncle are very distinctly defined. The form of the valve is distinct; and the membraneous or cartilaginal part of the peduncle is apparently, I could almost say obviously, in a corrugated and contracted state; and the commencement of the valve is bordered by a regular and well defined line: this, indeed, is the case with the specimen here represented.

At the sale of the Leverian Museum I purchased a specimen, which I suspect to be an English flint, although labelled "A pretty coral, from the East Indies." In this fossil are apparently two distinct peduncular bodies, with their attached valves: one displayed on the upper, and the other turned round on the under surface of the stone. In another specimen, four of these trachea-like bodies appear to have been united in one central body, by those ends most remote from the part which I have named the valve. But whether this fossil has belonged to the genus *Anatifa* or not, the different states in which the trachea-like body is seen, almost demonstrate that it was a part capable of elongation and contraction, as circumstances required.

It is evident that many of the rugous and striated pebbles have formed parts of this fossil body: others, undoubtedly, owe their rugæ to other fossils; among which, I believe, the orthoceratites may be mentioned.

Having now concluded the examination of fossil shells, *Conchyliolithi*, I must again say a few words in anticipation of the censures which may await me, from those who may think the classification I have adopted, with its manifold genera, a too wide and improper deviation from that of the great Linnæus. Had I too have treated of recent shells, a slight deviation might have been sufficient; but when fossil shells are the subjects of our inquiry, this is not sufficient. Few of these, comparatively, were known in that classification: many of them were even without names, except such as were derived from some erroneous notion of their origin; but, by the classification of Lamarck, there hardly remains any among the fossil-shells, whose generic situations are not now clearly ascertained.

LETTER XVI.

FOSSIL FISH....OF VESTENA NUOVA, PAPPENHEIM, MANSFELD, &c.... OF ENGLAND.

The examination of the various circumstances which offer themselves to our observation, whilst contemplating the fossil remains of fishes, cannot fail of being highly interesting, and is at the same time very likely to throw some light on the mysterious events by which their deaths and their subsequent conservation has been effected.

These curious remains exist in various parts of the world; but the repository most abundant in these fossils appears to be that of the mountain *Vestena nova*, improperly named *Monte Bolca*.

This quarry was formerly purchased by the learned Scipio Maffei, who spared no pains in acquiring the rich specimens which it yielded. In these researches he was assisted by the celebrated Seguier, who there formed an inestimable collection, which is now placed in the

central school of the department of Gard. But the most important and valuable collection of these fossils is that which was formed, at a vast expense, by the Count de Gazzola, of Verona, who had a considerable number of these fishes engraved, many of which he had published, in three parts of a most splendid work, the continuation of which was prevented by the successes of Bonaparte, who, in the words of M. Faujas, " se concerta avec ce savant, pour acquerir de grè à grè ce cabinet unique," p. 110. In consequence, it now forms a part of the National Museum of Natural History at Paris.

Near to Schio, in the Vincentino, similar fish are found with echinites and shells, in a grey calcareous stone, mixed with clay and quartzose sand. Small chetodons are also found in a brown bituminous argillo-calcareous schist, belonging to a coal-mine, not yet dug, at Monteviale, near to Vicenzo. At Salzeo, situated at the foot of that part of the Alps which joins to the Tyrolean mountains, are found similar fish with those of Monteviale, in a black pyritous fragile schist: in which are also observable the impressions of marine plants, of polypodies, and of compressed wood. Small fish are also found at Tolmezzo, a small town of Frioul, and at Cerigo, in the Archipelago, in a fissile stone resembling that of Vestena Nuova. At Alessano, a province of Otranto, small fishes are found, in a very white calcareous silt. In the Island of Lesina, in Dalmatia, fossil fish are also found, with the polish still visible on their scales, in a hard, sonorous, and foliated reddish lime-stone. At Scapezzano, and in Monto Alto, in the duchy of Urbin, and in the promontory of Focara, in the same duchy, similar fossils are also found; and in the latter place, they are said to be mixed, in a confused state, with rounded and rubbled porous lava. At Stabia, to the West of Castellamare, Scipio Breislak found, in a calcareous fissile stone, impressions of one particular species of fish only, called at Naples *Sbaraglioni, Sparus guarraccinus.* And the same naturalist was informed, by M. Fortis, that the icthyolites of Pietra Roja, near Cerreto, have two particularities: the one

is, that the fish, on splitting the stone, is not divided, but remains on one side, leaving its impression on the opposite; the other is, that the bony parts of the fish are changed into silicious matter*.

At Gijon, in Naples, fish are found in a black fissile stone, and mostly in a good state of conservation. But the black schist, in which these remains are found in the greatest number, and in the best state of preservation, is in the neighbourhood of Eisleben, in the county of Mansfeld, in Upper Saxony. This schist, which is argillaceous, is very hard and black, and lies over coal. The fish are in various states, some lying straight, others bent; but all of them evidently much compressed. The whole surface of the impression is as if varnished, or, according to Mylius, as if covered with naphtha; and many of the scales are entirely resplendent and variously coloured, from their having become pyritous; from which circumstance, these specimens often possess a very beautiful appearance. In a specimen of this kind, from the Leverian Museum, almost all the scales on one side are in a pyritous state, and the opposite part of the schist, bearing the exact form of the fish, is covered with a fine grey pyritous film.

Mr. Knorr observes, that in general we may be able to determine the situation in which these fossils were placed in the quarry; since, on splitting the stone, the fish is most commonly adherent to the upper plate, whilst, on the lower plate, the impression only exists. M. Kruger is of opinion, that the scales do not exist in these specimens; but, that the lozenge-formed markings are the remains of the flesh. A white line or pellicle, he observes, may be perceived to surround the fish, if the stone is broken across; and, in this part, he believes the scales to have existed.

The fossil fish of Pappenheim and of Oeningen, near the lake of Constance, are found in considerable numbers, and in good preservation. The stratification of the quarry in which they are found is, according to the celebrated Saussure, 1. one inch of a grey, loose,

* Voyages Physiques, &c. par Scipion Breislak, p. 20.

fine-grained sand-stone; 2. four inches of clay, intermixed with lime; 3. two feet two inches of a foliated marley clay, with traces of bitumen; 4. one foot of a calcareous schist of a yellowish grey, intermixed with flakes of rather bituminous clay; 5. eight feet of a fissil schist, partly calcareous, in thin plates, and alternating with beds of friable clay; 6. twelve feet of a hard fawn-coloured lime-stone, formed in flags and in beds, possessing more or less thickness: but very thin in some parts, and having the divisions marked by fine traces of a brown matter, which yields a bituminous odour with heat. In this stone are found the fish, and with them shells, insects, some small amphibiæ, and the impressions of leaves.

At Aix, in Provence, M. Faujas informs us, fossil fish are found, resembling, in their size and state of preservation, those of Vestena Nuova. This quarry is formed of, 1. a schistose marle, of many feet in thickness, which forms the roof; 2. a white calcareous stone, containing about one fourth of clay; 3. a pretty hard calcareous bed; 4. a schistose marle, like that of the roof, containing crystals of selenite; 5. to this succeeds a fissile stone, a mixture of lime, clay, and bitumen, of a light yellowish grey colour, detaching in flakes, on which are discovered the remains and impressions of fish, which are in general well preserved, and are from six inches to even two feet in length. The extinct volcanoes of Beaulieu are about three leagues distant.

At Montmartre the remains of fish are also found in a marley lime-stone, which is over the plaster quarry; but the bed in which the fossil fish are found at Aix, is beneath the plaster stone. From Nanterre, near Paris, M. Faujas obtained a fossil fish, more than ten inches long, in solid lime-stone, taken from seventeen feet below the surface. This fish, he thinks, bears a near resemblance to *Coryphena chrysurus*, Lacepede. M. Faujas himself discovered, half way up the side of the mountain on which is built the castle of Rochesauve, and beneath more than twelve hundred feet of what he terms lava of different kinds, surmounted by vast basaltic masses, a fine and light

grey marle, in which existed several leaves of trees and of plants, many of which were, he says, indigenous to the South of France, whilst others appeared to be foreign to the climate. Among these were also found the remains of fishes, which he ascertained to be *idus, pinna ani radiis* 13, *ventre plano.*

The following particulars respecting the fossil fish of Monte Bolca and the circumstances under which they are found, as given by the Rev. Mr. Graydon, *Transactions of the Irish Academy*, Vol. v. p. 281, are particularly interesting.

Monte Bolca lies on the border of the Veronese territory, about fifty miles W.N.W. of the Lagunes of Venice, which is supposed to be the nearest sea. Its height has not been ascertained, but it is pretty considerable. It forms one of the chain, or ladder, of secondary hills, which from some distance from the adjoining Vicentine, rise gradually above one another, to the Alps of the bishopric of Trent. Great part of this tract has been considered by many naturalists as being covered with productions of extinct volcanoes; but the supposed compact lava of the Vicentine and Veronese is wholly of the argillaceous genus, and of the traph or horn-blend species, resembling basalt: indeed, the summit of this hill itself was many years ago, discovered, by Abate Fortis, to be crowned with a great mass of tolerably defined columnar basalt.

The whole of the hill, as far as I could observe, Mr. Graydon says, seems to be composed of similar, or at least of argillaceous matter, except the quarries in which the fish are found, which are calcareous, and lie at about half a mile from the summit. Besides the dissimilarity of these to the other materials of the hill, it is further important to remark, that they do not form a continued stratum, but lie in great and wholly detached and distinct masses, as it were accidentally imbedded in the side of the hill, set in a loose rubble of argillaceous and the same kind of calcareous fragments, the whole, more or less, in a state of decomposition.

What is most remarkable is, that these fish are described as the modern natives of various seas, most remote from each other, and not

of Europe only, but of Asia, the Indian Ocean, the South Sea, Africa, North and South America; and, in addition to these, some few of fresh water.

M. Bozza, the original proprietor of the soil, speaking of his collection, in a paper published by him, says: "In my cabinet, which contained upwards of six hundred fish of different sizes, all extracted from Bolca, there are more than one hundred whose kinds are known, which differ from each other in genus and species, and *many others besides, to which similar living ones have not yet been discovered.*" In another passage he adds: "The first decade of fish published by M. Broussonet, has ascertained to us, that many of these found at Bolca are natives of the South Sea—of these I have four, which agree exactly in form, in proportions, and in fins, with four described by M. Broussonet, which are peculiar to the sea of Otaheite, which are the *polynemus plebeius*, or *Emoi* of the Otaheiteans; the *Gobius striatus*, which they call *Jaipoa;* the *Chætoden triostegus*, and the *Gobius oscellaris*." These perfectly correspond with the fish given by Sir Joseph Banks to M. Broussonet.

The stone has been generally termed a marle or marley schist. It is a whitish, yellowish, or bluish grey, and in general yields easily to the knife, emitting at the same time, a peculiar fetid smell, differing considerably from the smell of the common *lapis suillus*.

The forms of the fishes are well defined, and the harder parts are remarkably well expressed. The dark brown matter composing these fish remains distinct, and may be picked off from the stone, and projects in proportion to the thickness of each part in its natural state. It is hard, brittle, and rather glossy, through its substance, except in some of the grosser bones, such as the joints of the vertebræ; which, though of this appearance externally, are found, when broken, to consist internally of laminer crystallized calcareous spar.

Mr. Graydon proposes a very ingenious explanation of the phenomena yielded by the fish of Monte Bolca and their surrounding matrix.

He supposes the fine light-coloured calcareous mass in which they are imbedded to have been formed by the deposition of carbonate of lime from lime-stone heated by volcanic fires, and plunged in this state in the ocean. By this means, he thinks the fish would be destroyed, and would remain in the calcareous magma, which, as it became condensed, would retain and absorb the putrid gases evolved from the fish, and would thereby become a stink-stone, yielding its peculiarly offensive smell by attrition.

The British Isles are not so productive of this class of fossils as are several of the places on the Continent, which have been just particularized. In Oxfordshire, Gloucestershire, Leicestershire, Lincolnshire, Dorsetshire, and Kent, however, some specimens of entire, or nearly entire fishes have been found.

In Mr. Donovan's collection is a very beautiful and complete impression of a small fish on Portland stone. This fish much resembles a smelt in size and form. In the same collection is a very fair and perfect impression of a small fish, in bluish lime-stone, from Burford, in Oxfordshire; but which I have never had the opportunity of examining so closely, as to be authorized in forming an opinion under what genus it might be placed.

The Hon. Daines Barrington communicated to the Royal Society, in 1755, the figure and description of a fossil, found at Bath, which he conceived to be part of a fossil beaver's tail. A comparison, however, of this fossil, with some specimens which were formerly in Mr. Strange's Museum, and which were found in the neighbourhood of Weymouth, determines this fossil to be part of a fish.

This is plainly evinced in one of these specimens, in which the form of the body is observable, and its upper and lower terminations are nearly preserved. From the comparative thinness and width of the body, it may perhaps be considered as of the family *Leptosomes*, of Dumeril, and of the genus *Pleuronectes*. As neither the fins nor the gills are preserved, in any specimen which I have seen, no opinion

can be formed with respect to its generic or specific resemblances. The square scales with which its body is covered, and which are so large in proportion to the size of the animal, render it different, I believe, from any recent fish which has been yet described. A patch of these scales is represented Plate XVI. Fig. 12.

Numerous remains of fishes are found in the pyritous clay of Shepey; but in so mutilated a state, as not to allow of forming any probable conjecture as to the relationship which they may bear to any existing fish.

"Our own country hath lately afforded what (says Mr. Jones) I apprehend to be the greatest curiosity of this sort that ever yet appeared. It is the entire figure of a bream, more than a foot in length, and of a proportionable depth, with the scales, fins, and gills, fairly projecting from the surface, like a sculpture in relievo, and with all the lineaments, even to the most minute fibres of the tail, so complete, that the like has not been seen before. It was taken from the stone quarries of Barrow, in Lincolnshire, and is now, by a fortunate circumstance, in the possession of the learned Mr. Green, Woodwardian Professor of Fossils in the University of Cambridge." P. 411.

"Another very fine fossil fish, of a different constitution, was discovered in a block of Leicestershire coal, at the house of the late Sir J. Robinson, in Northamptonshire. It is a considerable part of the body of a salmon (or rather the image of what once was its body), in a white sand-stone, with the lineaments of the scales. The cavity of the body is filled with coal, which is a very singular circumstance. It was lately presented, by Sir George Robinson, to Sir Ashton Lever, and is now preserved in his Museum*."

We are, however, by no means to admit of the existence of an identity of species, between fossil and recent fish, in all the instances in which it has been claimed. Similarity of appearance is by no means sufficient to warrant a decision in these cases; the specific, or at least

* Physiological Disquisitions, &c. by William Jones, F.R.S. 1781.

the generic characters, should be discoverable in the fossil specimen; which is not the case, at least, in the figure of the fossil fish considered by Mr. Jones as a bream. The fossil also, above described, as being part of a salmon, Mr. Jones afterwards discovered to be the remains of a vegetable, and took the first opportunity to acknowledge his error.

The paucity of fossil fish is attributed, by M. Faujas, to the quickness with which fish are decomposed after death, and to the vast numbers which are destroyed by the stronger devouring the weak. But these two circumstances by no means account for this interesting fact. It is true, that the flesh may, if exposed to the air, soon run into putrefaction; but even then, the bones in the spinous fishes, and the scales and spiculæ, would be left; the two latter being, as has been observed by Mr. Hatchett, true bony substances, containing much phosphate of lime, with a greater proportion of the membranaceous part than in common bone. The destructive wars between these animals must immediately be seen to have no bearing on this particular fact; since, if the waters continued to be well peopled, the number of fossils of this class would not be thereby diminished.

I should not have noticed the insufficiency of M. Faujas's arguments, but from a fear lest they should have been too easily admitted, and the further consideration of this important fact too speedily closed. I am the more anxious to prevent this, since I conceive that the desired explanation may be more likely to be found in the circumstances under which the bed was formed, in which they have become mineralized.

The same writer conceives that the opinion of the fish of Vestena Nova having been instantly killed *(asphixies subitement)*, is supported by the position and the horizontal and tranquil situation in which they are found: *Essai de Geologie*, p. 107. It may be sufficient, to show how little reliance is to be placed on this reasoning, to observe, that the celebrated Werner has deduced the same inference from the opposite fact; he being of opinion, from the contorted aspect of the

fish, in the bituminous slate of Mansfeldt, that the fish have been suddenly killed by an irruption or instantaneous formation of sulphureo-metallic matter*.

Nor does the particular circumstance which has been so much insisted upon, as a proof of this opinion of M. Faujas, appear to be at all conclusive. The circumstance to which I allude is, that which is displayed in one of the specimens from Vestena Nuova, in the Museum of Natural History at Paris. In this specimen a pike is seen, which has died, with another fish of the same species still in his throat; it having been supposed that its instantaneous death was produced by a sudden volcanic irruption into the water, at the moment of its having swallowed its prey.

The fact, however, really is, that fossil fish are found in all the different quarries in which they exist, in almost every state and position which can be conceived. Sometimes, with their altered flesh still covering their bones, and at other times the skeleton only is preserved. Many are seen laid out in a straight line, but nearly as many are also seen in various contorted positions.

There are no fossil remains of any class of animals, except, perhaps, of the *Crustacea*, which accord so much with the existing genera, and even species, as those of fish, The proportion, indeed, of fossil fish, which have existing analogues, is so great, as to render it by no means improbable, considering how frequently, in the present day, new genera are discovered, that the analogues of such as are now only known in a mineralized state may yet be found.

Among the fossil fish, whose living analogues are known, the pike, the carp, the perch, the eel, the sea-scorpion, the scarus, the mackarel, the turbot, the sword-fish, lod, gadus mustela, gobius, and several others, have been mentioned by different authors, among the fishes found in the neighbourhood of Verona. M. Faujas particularizes a *Fistularia*, of Japan; a pegasus, of the Indian Sea and of Brazil; and three cheto-

* System of Mineralogy, by Mr. Jamieson, vol. i. p. 530.

dons of India. M. Lacepede, in the preliminary discourse to the second volume of his Natural History of Fishes, informs us, that more than thirty Asiatic, African, and American species of fishes, have been here discovered. M. Fortis also observes, in a letter to M. Faujas, that the approximation which he has been able to make of these fishes to the figures of those of Otaheite, published by Broussonnet, has convinced him, that it is absolutely in that distant sea that the actually living descendants of the ancient generation, now found mummified in the quarry of Vestena Nuova, are to be sought for: as it is in these same parts that we find the originals of almost all the petrified shells of the mountains of Verona and of Vicentino*.

LETTER XVII.

PARTS OF FISHES......HEAD, EYES, JAWS, TEETH, PALATES, PROBOSCIDES, SCALES, BONES, &c.

It is sometimes difficult, when separated from the parts with which they were originally united, to refer the fossil remains of fishes to the real situation which they held in the living animal, or to ascertain the offices which they performed. In many of these instances we may, however, derive considerable assistance from the examination of the analogous parts in living animals.

The heads of fishes are very frequently found among the Shepey fossils, and have sometimes been supposed to bear a strong resemblance to known species, as the pike, gurnard, &c. In some of these an appearance is observable, although rarely, which gives the idea of

* Essai de Geologie, p. 112.

the eye of the animal having been petrified: and a careful examination of this part allows me to suppose that it is, in fact, either the *Cornea* or the *Membrana nictitans,* which has been thus preserved. I have been led to this supposition by discovering, by means of a lens, that in one specimen this part retains an uncommonly smooth and polished surface, whilst, in another, it has such a rugous appearance, as might be expected to be found in the *membrana nictitans,* on being exposed to the action of moisture after death.

In some of these specimens, the branchial operculum, or covering of the gills, is found in very tolerable preservation; in others the bony rays of the fins are preserved; and in most, where it is possible to remove the adherent matrix, which is rarely the case, the bones of the head may be displayed, *in situ,* and very interesting fossils thereby obtained.

The jaws of the spinous fishes are also sometimes found in a very tolerable state of preservation; being sometimes closed, and other times very widely separated. In the British Museum is an uncommonly beautiful specimen of the skin of the under lip of a fish in a mineralized state, and in perfect preservation. This is the only fossil of the kind that I have seen; nor can its rarity be wondered at, when it is considered, that the proneness to decomposition, in this part, can hardly be expected to give time for the impregnation necessary for its mineralization.

The teeth of fish are, from their nature and structure, among the best preserved and most numerous fossil remains of these animals. From the number in which they exist, they particularly engaged the attention of the early oryctologists, who distinguished them by names chiefly derived from their forms. Hence we find them spoken of by the names of *Glossopetra, Plectronites, Rostrago, Falcatula, &c.* *Glossopetra* was, however, employed as the general term, expressive of a tongue converted into stone: and, from certain differences in their size and forms, these were supposed to have been the tongues of birds, serpents, &c. Gesner, Reiskius, Lang, and others, regarded them as sports of nature; but Steno and Fabius Columna at once

asserted their animal origin, and pointed out the animal to which they conceived they had belonged.

These fossils vary considerably in their size and form: some scarcely exceeding a quarter of an inch, whilst others are full five inches in length; some being triangular and flat; some long, straight, and conical; and others very nearly resembling, in form, the beak of a bird. The great variety in their forms serves to show us, that the animals from which they derived their origin must have differed materially from each other.

The large triangular glossopetræ, with nearly straight and finely jagged edges, rather an obtuse apex, and a flattish or slightly-forked base, appears to have belonged to an animal differing, at least in its magnitude, from any animal with which we are acquainted, that is furnished with teeth of a similar form. The specimen Plate XIX. Fig. 11, though inferior to many in size, must have belonged to an enormous animal: it is four inches and a half long, and three inches and a half wide at its base. M. Lacepede has made some very ingenious calculations respecting the size of the shark to which a fossil tooth in the National Museum had belonged, which tooth was rather smaller than the one here figured; and he concludes, that it could not have been less than seventy feet nine inches in length.

These teeth have been supposed to approach the nearest in form to those of the white shark *Squalus carcharias*, Linn.; and calculating the size of the animal, to which some of these fossil teeth have belonged, from the size of the teeth in the white shark of the present time, it cannot be doubted that some of these animals must have been at least an hundred feet in length.

These teeth, from their supposed origin from these animals, have been named *Carchariodontes*. They have been also called *Lamiodontes*, from these animals having been named *Lamiæ*, by the earlier naturalists. They have been found in different parts of the world; but, in the greatest numbers, in Malta and the neighbouring islands.

Teeth of a nearly similar form, but of much less magnitude, are also frequently found. It is difficult to say whether these have belonged to young animals of the same species as those which bore the teeth just described, or to animals specifically distinct. The circumstance, however, of the vast difference in size, leads me to believe the latter to be the case. Plate XIX. Fig. 2 and 9, represent some of the smaller specimens of triangular teeth.

The straight conical glossopetræ have been supposed to resemble the tongue or beak of a raven, and have been named *Ornithoglossæ* and *Grazirrhinchi.* These appear to have belonged to fish approximating very nearly to those to which the preceding teeth have belonged. Scilla, who carefully examined the fossils of this description, supposed these fossil teeth to have belonged to that species of shark which the Messinese have named *Stampella*, (*Squalus zygena*, Linn.) the balance-fish, of which fish he gives a correct figure, as well as three figures of the accordant fossil teeth, so frequently found at Malta*. A representation of a fossil tooth from Malta, of this species, is given Plate XIX. Fig. 2.

The fossil tooth from the Kentish chalk-pits, Plate XIX. Fig. 3, very much accords with the description of the teeth of the *Squalus galeus*, Linn. Its length hardly exceeds its width; and its point is so much inclined to one side, as to form a notch on that side. The edges are very finely serrated. The teeth of the *Squalus mustelus*, according to M. Cuvier, agree in form with the preceding, but are scarcely at all jagged on their internal edge. It seems to be to this species that the teeth named *Acanthiodontes*, and figured by Lhwydd, No. 1417, may be referred.

The fossil tooth, Plate XIX. Fig. 5, rising into a sharp simple point, with a small point on each side, projecting immediately from the root, resembles, in these characters, the teeth of the *Squalus cinereus*. All

* De Corp. Marin. Lap. Tab. XXVIII. Fig. II. III.

the teeth of the *Squalus stellaris* are also long, and pointed with a small point on each side, at the base, like the last figured tooth. In the *Squalus nasus* are similar teeth, but not so numerous as in *S. stellaris.*

Triangular teeth, with three points, are the *Glossopetræ tricuspidæ læves, tridentulæ*, Luidii. Teeth of this figure are found in the Isle of Shepey, and are generally of a dark colour, from ferruginous impregnation, Plate XIX. Fig. 5. Teeth of this figure are sometimes, but very rarely found, with their surfaces covered with close longitudinal striæ, and bearing a very high polish. The specimen, Plate XIX. Fig. 10, is a magnified representation of one of these, from a mass in which are several other teeth, which, though varying considerably in their form, are all evidently of the same fish, and all have similar markings. This mass was found at the Old Passage, Gloucestershire, by Mr. Johnson, of Bristol, who has a beautiful mass of similar teeth, but of a larger size, which he obtained from Charmouth.

In the *Squalus squatina* the teeth are simply pointed, with a broad base, but with no lateral points; somewhat resembling Plate XIX. Fig. 9. In the *Squalus maximus* and *glaucus* the teeth have a sharp cutting edge only, agreeing nearly with Plate XIX. Fig. 2.

Spallanzani speaks of the very singular dentature of two jaws similar to that of the *Squalus* of Messina, which, he thinks, has not been yet described. These jaws were brought, with a number of exotic fishes, from Holland, and appear to have belonged to a very large *Squalus*, but of a species hitherto unknown; at least, he says, he does not find teeth of a similar structure described by any writer. The opening of the jaws is full three feet and a half in circuit, and consequently large enough to receive a man of middling size lengthwise*.

The figures of these teeth, as given by Spallanzani, exactly agree with those which are given by Scilla, as belonging to the kind of dog-fish, which have obtained, in the Mediterranean, the name of Colom-

* Travels in the Two Sicilies, Vol. IV. p. 370.

bina, or Vacca, and which he thinks may be, perhaps, the same fish of which Aldrovandus speaks, Lib. 3. Cap. 52. Scilla gives a representation of the head and jaws of this fish, in which the agreement with the jaws described by Spallanzani is very evident. Plate XVIII. Fig. 10, is a fossil tooth of this species from my collection, which is very small. Fig. 11, is one figured by Scilla; and each exactly agree, in form, with those of the recent fish both of Scilla and of Spallanzani.

It is worthy of observation, that the triangular Glossopetræ are never found attached to any bony substance; a circumstance confirming the opinion of their having originally been the teeth of fishes of the genus *Squalus*. The teeth of this genus, as has been some time since remarked by Scilla, and very lately by Spallanzani, not being placed in bony sockets, but implanted in a hard and fungous flesh; and which, decaying by putrefaction, allows the teeth to become detached.

Conichthyodontes striati. These rare fossils are very exactly described, by M. Walch, as being of a conical form, round on all sides, with the superior termination, as it were, truncated; and the whole surface of the teeth so covered with longitudinal striæ, as to give them somewhat of the appearance of a Dentalite. These are sometimes found in the quarries of Chippenham, and of other parts of Wiltshire and Oxfordshire. One of these fossils is represented Plate XIX. Fig. 4.

The straight or slightly bent conical teeth, *Conichthyodontes recti teretes,* have been termed *Plectronitæ* and *Rostragines;* and, indeed, are frequently called *birds' bills* by the quarrymen who find them. Plate XIX. Fig. 8.

The teeth of which I have hitherto spoken may be considered as being of the class of *Incisores*, and as being of the most decided kinds. There are others, which differ from these in their forms; but so little, as not to require further notice here: such are those, which display little degrees of variety of curvature, or which have suffered some change of figure from accident.

The molar teeth, which are placed in the back part of the jaws,

and even on the palate and in the back part of the fauces, are the next subjects for our examination. These have been long known in their mineralized state; and some of them, for their imaginary virtues, have been held in very high estimation. These are the fossils generally known as *Bufonites*, and are also called Serpents' eyes, *Batrachites*, and *Crapaudines*, from the notion of their having been formed in the heads of serpents, toads, or frogs; and, on account of their assumed virtues, were preserved, and set in rings and other ornamental articles. A large specimen of this kind is represented Plate XIX. Fig. 6.

Their real origin has, however, been long ascertained. They are the rounded grinders of the jaw and palate of fishes of the genus *Anarhicas*, and chiefly, perhaps, of the *Anarhicas lupus*. In this fish there are six and more sharp and conical fore-teeth in each jaw; and behind these, in the lower jaw and in the palate, are disposed the round molares, or bufonites. With these weapons they are able to crush the crustaceous or testaceous coverings of different marine animals, and thus obtain their prey. It is even said they will gnaw, and leave the marks of their teeth on the anchors of ships. From the considerable size of these bodies, in the teeth of recent fish, it does not appear that the size of the fishes, in the jaws of which the bufonites, or fossil teeth, had been formed, had vastly exceeded that of the wolf-fish of the present day. In part of a recent jaw before me, these molar teeth are of a very large size in proportion to the bones of the jaw.

It is extremely probable, that some of the smaller bufonites are the molar teeth of the genus *Sparus;* and particularly *S. sargus*, *S. dentex*, and *S. aurata*, or Gilthead, similar teeth existing in the jaws of these fishes. In the recent jaws and palates of these fishes, secondary teeth of this kind may be seen concealed in the cancellous part of the bone, ready to be propelled, as any of those already in use are broken away. Plate XIX. Fig. 7, is an interesting specimen, displaying three rows of moderate-sized bufonitæ, imbedded in their

original bone. Plate XIX. Fig. 12, are two bufonitæ, attached to a part of the jaw, and supported by their original columnar bony processes.

Sir Hans Sloane relates, that among some fossils which were shown to him from Maryland, he perceived one which agreed very closely with the bony tongue of a fish which he had seen in Jamaica; and on comparison with a tongue of this kind, found in Mr. Charlton's collection, from the *Pastinaca marina*, he found their agreement very exact*.

I am happy in being able to place before you two illustrative specimens of this kind. Plate XIX. Fig. 16, is a fossil from the Isle of Shepey, which appears to have belonged to some fish of the genus *Raia*, being very closely accordant with the recent bony tongue of the fish of this genus, figured, in outline, Plate XIX. Fig. 13. I have another recent specimen of this kind, the jointed bone of which is longer, and exactly agrees with that figured, by Sir Hans Sloane, as the tongue of the *Raia pastinaca*.

Another fossil specimen of this kind, in my possession, is considerably larger than the one which I have here figured: and in my friend Mr. Crow's collection, of Faversham, is one which is six inches in length, and three inches and a quarter in breadth.

The structure of this body, as is most evident in the analogous recent specimen, is singular and interesting. It is formed of two horizontally-disposed laminæ; the upper of which is of a very close and dense structure, and forms the masticating surface; the other is of a more cellular texture. Both these substances are transversely divided into six plates, which are united to each other by very fine and close sutures, and have a row of interstitial substances, of a hexagonal form, placed between their lateral terminations. This body, as appears in the recent specimen, was attached to the surrounding bones: the masticating surface is placed upwards in the fossil, as well as in the recent specimen.

* Phil. Trans. Vol. XIX. No. 232.

Plate XIX. Fig. 17, is another fossil from Shepey, the general structure of which agrees with the preceding, excepting that, in this body, there appears to have been two rows of hexagonal bodies. As, in the preceding figure, the masticating surface was shown; so here the other surface, the bony base, is shown; and this chiefly for the purpose of showing the perpendicular fibres, which, giving to this surface a brushlike appearance, induced Lhwydd to give the name of *Scopula litoralis* to this fossil.

The comminuting surface of the first of these fossils, Plate XIX. Fig. 16, is gently convex; whilst that of the latter, Fig. 17, possesses a correspondent degree of concavity. From this circumstance I am led to suppose, that the former has been the lower part or tongue, and the latter the upper part or palate, of perhaps the same species of fish.

Plate XIX. Fig. 14, is another fossil palate, of a different species. This differs from the preceding species not only in the form of its plates, but in its structure. The lateral substances are here plates, lying over each other, like the tiles of a roof, ready to succeed, as the upper plates are worn or broken away. The substance of the plates, in this specimen, when examined by a lens, are seen to be very different from that of bone; appearing, indeed, rather deserving a place between enamel and horn: possessing, with a denseness of structure like that of the former substance, a small degree of the transparency observable in the latter.

Those bodies which are called by the quarrymen petrified leeches, of which one is figured Plate XIX. Fig. 15, and which are frequently found in the lime-stone of Wiltshire and of Oxfordshire, were termed by Da Costa *Palatum limax*, or the slug-palate. These bodies are of an oblong figure, and generally a little pointed towards their ends. Their colour is of a dark brown, and they frequently possess a tolerable polish. On their upper surface are innumerable fine and slightly undulating rugæ, which commence at the sides, and sometimes unite in a fine irregular line, which passes longitudinally along the middle of

this surface. The whole appearance of this fossil very much resembles that of a leech or slug in a contracted state.

From these bodies having been found regularly disposed together, and particularly from one instance mentioned by Mr. Walcot, in which twenty-five of these oblong bodies were regularly placed in four rows, there can be no doubt that they are not single palates ; but that many of them, regularly disposed, constituted the platform of the palate of some unknown fish.

The palate of another species of unknown fish appears to have been formed by the regular arrangement of quadrangular bodies, a beautiful specimen of one of which is figured Plate XIX. Fig. 18. The hard part of these bodies, corresponding to the enamel of teeth, is disposed, on the middle part of the upper surface, in sharp and slightly-curved ridges, alternating with corresponding depressions. These are surrounded by a border, formed of obtuse papillæ and rugæ, disposed in a very confused and irregular manner. In some specimens, this border is not present. These palates are chiefly found among the chalk of Kent and Surrey. The most interesting fossil of this description, which I possess, is one which is embedded in the centre of a nodule of flint.

The fossil, Plate XVIII. Fig. 12, is one of the component parts of the roof of the mouth of some other unknown fish. It resembles the preceding fossil in the disposition of its ridges,&c. but differs from it in having a much greater convexity, being full as high as it is long. It is found, though much more rarely than the former, in masses of chalk, and most frequently in the neighbourhood of Devizes, in Wiltshire.

Several of this, and of the two preceding species of fossil palates, were exposed to the action of dilute muriatic acid : when the existence of their membranous laminæ was evinced by numerous delicate *flocculi* becoming partly detached from the surface. In the leech-like palate, the phenomena which occurred were very interesting. After the fossil had been exposed about twelve hours to the action of the acid, its dark surface gradually disappeared, and was succeeded by one of a silvery

grey colour, having somewhat of a pearl-like lustre. On this being examined with a lens, it was found to be an exceedingly fine membrane, which, on being touched with the finger, was immediately removed, and with it the rugæ with which the surface had been originally marked. On being suffered to dry, the surface became of a dead white, and marked the fingers, the rugæ being nearly effaced.

A portion of flat bone, about a foot in length, and four inches broad, bearing a general resemblance to the saw of the saw-fish *(Pristis)* with apertures or sockets for the lateral teeth, very distinct along each side, from Gloucestershire, was exhibited in the Leverian, and, since, in the London Museum.

In the neighbourhood of Bath is found a fossil proboscis, or jaw, of some unknown animal, of a curious form. It is long and tapering; seldom, however, exceeding six inches in length, of a dark brown colour, or nearly black: it is flat, and fluted on its two broader sides: and, on one of its edges, has a series of small teeth disposed in a straight line. Not the least curious of the weapons of the finny tribe is a spear-formed bony substance, of a dark brown colour, found in the Isle of Shepey, which I purchased from the collection of Mr. Strange. It is of a conical form, tapering nearly to a point; eight inches in length, and three inches in width, at its largest part. It appears to have been the proboscis of some unknown fish.

The scales of fishes are frequently found in a state of high preservation in the pyritous clay of Shepey, sometimes possessing even a metallic lustre. They are also sometimes, but more rarely, found in the masses of chalk, and very rarely indeed in the flint nodules. Plate XVIII. Fig. 13, is a curiously-formed scale, found in the Kentish chalk-pits; and in Plate XVIII. Fig. 9, is shown a single scale, with its processes for attachment, found in a lump of calcareous matter, in Dorsetshire. This scale seems to differ only in size from those which are described Page 250, and figured Plate XVI. Fig. 12.

The bodies of the vertebræ are very frequently found both in pyritous

masses, and in the several lime-stone strata: but it is very rare to find them possessed of either their spinous or transverse processes. Among those fossils which have been described as scarce, are those vertebræ which bear somewhat of the form of an hour-glass. These, however, are by no means so rare as has been supposed, the vertebræ of fish in general approaching to this form.

When a longitudinal section of a series of the vertebræ of fish, imbedded, for instance, in lime-stone, is made, a series of bodies are seen, bearing the hour-glass form, each being the section of a body of a vertebra. For as there is a conical cavity both in the fore and hind part of each vertebra, from which results, when the vertebræ are united, a series of cavities bearing the form of two cones united at their base; so the body of each vertebra, narrowing to its centre, presents, by a longitudinal section, a surface which, in its longitudinal direction, bears the form of a longitudinally-divided hour-glass. It is in these cavities, formed by the union of the vertebræ, that the fluid is contained, which, according to the observations of Mr. Home, being incompressible, preserves a proper interval between the vertebræ, to allow of the play of the lateral elastic ligaments, and forms a ball round which the concave surfaces of the vertebræ are moved, and which readily adapts itself to every change which takes place in the form of the cavity*.

Among the Shepey fossils are sometimes found the last vertebræ of the tail. These are flat and of a triangular shape, and at their widest extremity frequently show the articulations of the small long bones which support the finny membrane of the tail. One of these is represented Plate XIV. Fig. 14; and another, of a peculiar form, is shown Plate XIV. Fig. 15.

* Phil. Trans. for 1809, p. 177.

LETTER XVII.

ENTOMOLITHI.......INSECTS IN PAPPENHEIM LIMESTONE.......IN COAL SLATE..... CRABS OF SHEPEY, VERONA, EAST-INDIES, AND MAESTRICHT.....ONISCITES.....MONOCULITES.....TRILOBITES.

The extreme softness of the parts, and the general delicacy of structure, which exist in the smaller insects, will easily explain the circumstance of their being rarely met with in a mineralized state. Very few indeed are the instances which I shall be able to adduce of *Entomolithi*, or of the mineralized remains of this class of animals.

The specimen represented Plate XVII. Fig. 2, is a slab of the fissile cream-coloured lime-stone from Pappenheim, in which the traces of an insect are sufficiently plain to mark its presence, without, however, being sufficiently distinct, to point out the genus in which it should be placed.

The head of the animal is plainly to be seen, but none of its parts are distinguishable. It appears to have been connected with the thorax by a contractile neck; since, in another specimen, apparently of the same species, the neck appears to be as long as the thorax; whilst, in the specimen here depicted, the distance between the head and the thorax is very small. The thorax appears to have been nearly cylindrical, and much shorter and wider than the abdomen, which is of a lanceolated form, and is evidently composed of about eight articulated rings. In one of M. Knorr's figures, Pl. XXXIII. the tail of this animal

terminates in three points; but the form of the tail varies in every one of the three specimens which I possess.

In one, the tail terminates in a bifurcation; and, by careful inspection with a lens, a fold is perceptible in the last articulating ring of the abdomen, which, it is evident, would have been obliterated by the approximation of the bifurcating points. That the animal, therefore, possessed the power of opening and of shutting these, appears to be highly probable; and the appearances yielded by another specimen authorizes the opinion, that these, on closing, formed a sheath for the sting of the animal; and, on being opened, left it in a state fit to inflict a wound. An apparently cylindrical body is seen standing out between the bifurcation, and may be even traced some little way within the abdomen. In a third specimen, which, from its having lost its legs, has very much the appearance of a *pupa*, the caudal termination is in a single point, giving to me the idea of the bifurcating points being united, and inclosing the sting.

Plate XVII. Fig. 2, *a*, represents the animal with the bifurcating sheath: *b*, shows the sting, which has passed out of the sheath: and *c*, shows the termination in a single point; which I suppose to be formed by the closing of the bifurcated sheath over the sting.

The most accurate examination which I have been able to make does not enable me to discover any traces of wings. The legs, which I am of opinion are eight in number, are attached to the breast. If these insects have not been despoiled of their wings, and if my observations have been correct, they cannot any longer be considered as belonging to the genus *Vespa*: but, it being admitted that they were apterous insects, I yet must acknowledge my inability to dispose of them under any known genus.

Lhwydd, in a postscript to a letter to Dr. Richardson, thus speaks of the remains of insects, which he had perceived in coal-slate.—"Scripsi olim suspicari me Araneorum quorundam icones, una cum *lithophytis*, in schisto carbonariâ observasse: hoc jam ulteriore expe-

rientiâ edoctus apertè assero.—Alias icones habeo quæ ad Scarabæorum genus quam proximè accedunt. In posterum ergo non tantùm *Lithophyta*, sed et quædam insecta in hoc lapide investigare conabimur." *Lithophylaccii*, p. 112.

Plate XVII. Fig. 3, 4, 5, and 6, are sketches of these insects, as given by Lhwydd, *Ichnograph.* Tab. 4.

The petrified nests of bees and wasps, of which some have spoken, may, I believe, be all referred to deceptive specimens of madreporites, or of septaria, in which the loose matter forming the *tali*, has allowed the crystallization to have formed small and numerous polygonal cells. The insects, which have been said to have been found in these cells, must have originated in an active imagination.

The only specimens which can have any pretensions to the term *Helmintholites*, are those of which the representation of one species is given Plate VI. Fig. 12, and of which the impression of another is shown Fig. 13. Both these fossils are from Oeningen.

The enormous length of this animal, and its knotted or jointed structure, with its numerous contortions, and its general form, serve to distinguish it decidedly from the earth-worm, with which it has been confounded by some authors. These peculiarities do not, however, enable us to discover any known genus in which it may be placed. Knorr, Wolfart, and other oryctologists, have figured several varieties of this very curious kind of animal. Baier denominates it *Lumbricus marinus petrificatus.*

The analogue of Plate XVII. Fig. 9, is, I believe, entirely unknown. By some it has been considered as the wing or wings of a moth or butterfly, and by others it has been supposed to be the scale of some species of fish or tortoise. For my own part, I acknowledge, that I can offer no conjecture respecting it; and therefore introduce its representation here, with the hope of obtaining some illustration of it, from any one who may have been led to make such observations as may assist in ascertaining its original nature.

I am unacquainted with the place where these fossils are found; but, from the nature of the matrix, suspect it to be Stunsfield, in Oxfordshire. The markings on the stone are so very thin, as to lead to the supposition that the fossil body has been removed, and has only left its impression and stain on the stone. The stone itself is a limestone, very full of Oolithes, with shells dispersed through it, exactly resembling the Stunsfield stone, in which are found the teeth and palates of fish. In another fossil of this kind, the markings vary so much from the preceding, as to render it, I think, deserving to be regarded as specifically different.

The wings of butterflies are said to have been found in a mineralized state; but this I very much doubt, suspecting that the opinion has been derived from some delusive appearances.

When you take into consideration the particular characters by which the several species of the genus *Cancer* are marked, and the injuries which the fossil animals of this genus have sustained, you will see, I trust, the very great difficulty of distinguishing the species even by those who possess, what I do not, an intimate knowledge of this branch of natural history, and an ample collection of both the recent and fossil objects of our inquiry.

It happens, indeed, very unfortunately, that in the fossil remains, traces of the antennæ, and the terminations of the hinder feet, are hardly ever to be seen. The containing crust of the animal, with some portions of its claws, are generally the only parts preserved; but the incisural and dentated markings on the sides and fore part of the former, and the terminations of the latter, are very seldom discoverable. It is only from the size and general forms of this kind of fossils, that we can offer any opinion with respect to their species; and, where the approximation of the fossil is, in this respect, near to the recent animals, but little prospect of success can exist in attempting to make a distinction between them.

I am entirely unable to say anything with respect to the specific

distinctions of any of the crabs which I possess. Mr. Francis Crow, of Faversham, is of opinion, that he possesses about twelve different fossil crabs, from Shepey; and in the collection of the London Museum, there existed, in the opinion of its learned possessor, more than three times as many; none of which he finds exactly agree with any in his extensive recent collection.

Plate XVII. Fig. 1 and 7, represent two different specimens of fossil crabs from the Isle of Shepey, distinguishable from each other by the markings on the dorsal plate. Crabs, apparently similar to those which are found at Shepey, are also obtained from the neighbourhood of Verona. Very fine fossil remains of this kind are also found in Malta, as well as in Anjou, in the department of Maine and Loire.

Fossil remains of lobsters are sometimes found, in very good preservation, in the Isle of Shepey.

We learn from M. Knorr, *Monum. des Catast.* T. I. p. 19, that the fossil remains of river animals of this genus, the cray-fish *(astaci)*, are found in no other part of the world, but in a narrow district, reaching from Gunzenhausen, in Anspach, to Aichstaedt, a length of about seven or eight leagues, bordered on one side by the river Altmuhl, which, he observes, abounds with animals of the same kind.

The matrix of these petrifactions is a fine light yellow lime-stone, which frequently separates in tables, by which the contained fossils are beautifully displayed. These animals appear to have been imbedded in their matrix during the precipitation of the calcareous particles from the fluid in which they had been held. A fossil shrimp, from these quarries, is shewn Plate XVII. Fig. 8.

Plate XVII. Fig. 12, is the representation of a fossil crab, from the East Indies. These fossils are known by the name of Ceylon crabs; they having been formerly brought into Europe by the Dutch, who used to state that they were brought from Ceylon, where only they were to be found. Father Martini, in his Chinese Atlas, relates,

on the authority of several Chinese, that similar crabs are found in a lake in China, and that they possess the wonderful property of changing into stone, immediately on their being taken out of the water.

These fossils are however, in fact, found, according to Bourguet, in different parts of the sea-coast of China, in the island of Hainan, and on the coasts of Japan and of Coromandel. They are generally very much mutilated; but their crust bears oftentimes more the appearance of that of a crab recently taken from the sea, than those of Shepey.

Plate XVII. Fig. 10, represents part of the claw of a crab, in its matrix, from St. Peter's Mountain, Maestricht. It is observed by Faujas St. Fond, that there is no fossil, in this and the neighbouring mountains, more frequent than claws of crabs; but it is an extremely remarkable circumstance, that, notwithstanding the abundance in which these remains are here found, no remains of the body, or of the other parts of the animal, are discovered. After long reflecting on this circumstance, this industrious inquirer thought it right to conclude, that these remains had belonged to some crab of the parasitic kind, as *Cancer bernhardus*, Linn. The softness and delicacy of every other part of its covering, except that of its claws, would, he thinks, satisfactorily explain why these alone have been thus preserved.

In confirmation of this opinion Latreille, a naturalist who has paid particular attention to the examination of crustacea, concludes, from the curvature, direction, and general form of the arm of the crab, figured in Faujas's work, and from the absence of any other part of the animal, that it must have belonged to an hermit crab, ***Pagurus bernhardus***. In both, he observes, the right arm is the strongest, and the form of the hand is the same; the only difference between them being a larger number of asperities on the finger of the fossil crab, which is also rather longer than that of the recent crab. The upper edge of the hand, too, of the recent animal, has also some

asperities, which are not observable on the fossil hand. But these, he thinks, may possibly have been removed by friction.

The fossil remains, Plate XVII. Fig. 11, 14, &c. which we shall now examine, possess so few of the appearances exhibited by any existing animal, as to have rendered many ingenious naturalists doubtful, whether they should consider them as the remains of a crustaceous or of a conchiferous shell.

Various names have been given to this fossil, derived chiefly from the three lobular divisions by which it is so particularly marked; but several appellations have also been applied to it, founded on these remains being sometimes found in a coiled, and sometimes in an extended state; as well as from the head and tail part being frequently found separated, and giving room for suspicion that they might belong to different animals. From Bromel this fossil received the name of ***Lapis insectiferus*** and ***Insectum vaginipenne;*** by Wolsterdorf, who considered it as a fossil bivalve, it was called ***Conchitus trilobus;*** by Hermann, ***Pectunculites trilobus imbricatus;*** by Da Costa, ***Pediculus marinus;*** by Linnæus, ***Entomolithes paradoxus;*** by Baumer, ***Trigonella striata;*** and by Wilke, ***Entomolithus cancriformis marini.***

Mr. Martin, who, in his ***Petrificata Derbiensia***, inquired, with considerable success, into the nature of this fossil, concluded that the original of the petrified insect, found in Derbyshire, was an ***oniscus***. But as we have been hitherto able to examine a part only of this animal, and as there appears to be very considerable differences in the forms of the fossils of this kind, which have been found in different parts, it seems to be advisable, until we gain further information, to form for it a temporary genus, which may be named and characterized *Trilobites*—the fossil crustaceous upper covering, oblong, convex, and surrounded by an entire margin: the head or thorax large and gibbous, with two tubercles or eyes: the back convex, formed of triarcuate, imbricating segments, generally agreeing in their number with the size of the animal: the tail varying in its size and form.

The Dudley fossil, or that species of this fossil which is found at Dudley, in Shropshire, is evidently the upper covering only of the animal, and appears to have been of a crustaceous nature. It is of an oblong ovate form, convex, and surrounded by an uninterrupted border. The head is large and gibbous, and divided longitudinally into three parts: the middle one rounded, gibbous, and rough, having at its posterior part two round projecting knobs, and just before these two smaller. On each side of this body is a triangular surface, from the centre of each of which proceeds a valvular projection, which, from its form, appears to have been capable of being occasionally opened or closed.

I acknowledge that, in the specimens which I possess, I am unable to discover the reticulated surface of the eye of this animal, of which many have spoken. Instead of this, I only find the lunated valvular projection, by which, it seems, the eye of the animal might be occasionally covered or exposed. A magnified representation of this part is given Fig. 14, *a*.

The back is formed of strong, convex, triarcuate segments, varying in number with the size of the animal, and diminishing in size, as they approach the caudal termination. These segments are more raised in their middle than at their sides; and in the recent animal, the superior, by sliding over the inferior ones, allowed the animal to make very considerable changes in its form, by extending or contracting itself, as is shown Plate XVII. Fig. 11 and 14. The tail is obtuse, and without any appendage. In no specimen has the under part of the animal been seen, consequently nothing can be said respecting the structure of this part, its legs, &c.

The Derbyshire trilobite differs from that of Dudley in being narrower, and particularly so at the upper part; in not having the four tubercles at the posterior part of the head, and in having the dorsal segments marked with a line of minute tubercles. Mr. Martin has given a representation of the reticulated surface of the eye in this animal.

On breaking the Dudley fossils, the inner surface of their covering is found marked with undulating striæ, the impressions of which are also found on the inclosed matrix. In none of the specimens which I have thus broken, or have rubbed down, have I been able to discover any remains of an inferior or ventral covering, corresponding with the upper one, which has been just described. M. Walch, indeed, observes, that no under covering, or plate, has been ever discovered.

A trilobite is represented in the Memoirs of the Swedish Academy, as possessing antennæ. This seems to have been the consequence of some mistake; since, in none of the specimens which have been since examined, has the appearance of such a part been ever seen.

Another species of this animal is found in the schistose strata in the neighbourhood of Llanelly, in Carmarthenshire. Plate XVII. Fig. 13. This differs from the preceding species in two material respects: the lateral lobular divisions are nearly three times as wide as the central one; and the outline of the animal approaches much nearer to the elliptical than the ovate form. From this latter circumstance, it obtains some slight resemblance to a sole, and has therefore been considered by some as the petrifaction of a fish of that tribe. The mutilated remains of this species, in consequence of the fossil being frequently severed transversely, have been regarded as petrified butterflies.

On the remains of one of these I have perceived a very curious structure: it is in that part of the fossil which presents itself to view on the removal of the external covering, and which was probably the cuticle of the animal. Here the form of the parts appears exactly to correspond with that of the crustaceous covering, being transversely and somewhat obliquely disposed; but, aided by the lens, the eye discovers, that this pellicle is marked by frequent and regular rugæ, as if the pellicle had been disposed in folds, not as in the outer coat, in a transverse, but in a longitudinal direction, Fig. 13, *b*.

Another species, the representation of a mutilated fragment of which is given Plate XVII. Fig. 16, is a very extraordinary fossil. In this

animal, the lobular divisions seem to have very nearly corresponded with those of the Dudley species. But the structure of the head part of the animal differs exceedingly from every other species. In this fossil, instead of the appearance of the distinct parts of a face, there are three large round protuberances, the middle being the largest; and all these protuberances are closely beset with small tubercular risings. These protuberances possess nearly the whole space of the head, the eyes being placed in the centre of each of the lateral risings. The matrix of this is a white fine limestone, but I am not able to say where it was obtained.

The fourth species, which is much more rare than any of the former, is almost always found imbedded in fuller's earth. The lower half of one of these is represented Plate XVII. Fig. 17. The form of the head I am unacquainted with. The structure of the back, and disposition of its plates, appear to agree with that of Llanelly; the central division of the plates terminating, like that of the Llanelly species, within a marginal line, which surrounds the divisions. From the inferior part of this line proceeds a long and narrow caudal process, which tapers as it descends, and appears to have been formed of a single plate or substance. These specimens seldom possess the process itself, the impression only of its lower surface being left, and which possesses somewhat of a bronzed appearance, probably from some stain which the fullers' earth has derived from the animal matter.

Plate XVII. Fig. 18, represents another species as imbedded in a nodule of iron-stone from the neighbourhood of Bewdley, in Shropshire—a spot exceedingly rich in fossil vegetable remains, as I may infer from the valuable collection with which I was favoured by Thomas Botfield, Esq. of Hopton Court, near Bewdley. The species of this animal, which is here preserved, differs essentially from any of those above described. Of the head, very little can be made out: it is evidently, however, much larger in proportion than that of any of the

former species. It is nearly semiorbicular, lunated posteriorly, and terminating at the sides in an acute angle. The body, which has only five transverse plates, is remarkably short; its sides going off directly from the head, and meeting speedily at an obtuse angle. From this point proceeds the tail of the animal, which is of a greater length than both the head and body. The structure of the tail may be here so far made out, as to enable us to ascertain that it is formed by a long central spine-like process, on each side of which a membrane has been evidently extended, wider than the process itself.

This fossil appears to be the same with *Monoculites lunatus* of Mr. Martin, Plate 45, Fig. 4, who supposed it to approach nearer, in size and figure, to the *Monoculus apus*, than to any other known recent species of that genus.

The opinions respecting the analogue of the trilobites have been very different. Some have supposed it a testaceous animal, and some have imagined it to be a coleopterous, whilst others have conjectured it to be an apterous insect. Guettard and Davila have placed it among the crustaceous animals. Linnæus, Mortimer, and Wilke, think it should be placed among the monoculi. Several writers have considered it as proper to place it among the bivalve shells; and Leigh, Hist. of Lancashire, Tab. VII. f. even regards it as a portion of a nautilus; Scheuchzer supposed that it might have been a patella; and Bruckman speaks of it as a polype. We must content ourselves, I believe, with allowing that no animal resembling it is known. Its surface, however, viewed with a lens, confirms the opinion of M. Walch and others, who have supposed it to be an animal of the crustaceous kind; the roughness resulting from the numerous little pits and risings appearing to be very similar to that of the crust of the crab, lobster, &c.

Plate XVII. Fig. 19, is the fossil remains of some crustaceous animal, which are frequently found with the trilobite in the Dudley lime-stone. The head part of the animal appears to have

been separated and removed: sufficient, however, of the animal here exists, to show that it is comparable with no known animal.

Plate XVII. Fig. 15, is the representation of the upper part of an extraordinary fossil; but with where it was found I am totally unacquainted. Its matrix is a ferruginous lime-stone, in which are discoverable particles of pyrites. It appears to be the dorsal plate of some enormous insect. On this plate regular transverse markings are observable, none of which are to be seen on the abdominal plate. It may, perhaps, be the remains of some huge insect of the genus *Oniscus*, or rather *Monoculus*; but it differs so much from any known animal, as to render guessing at even its genus presumptuous.

LETTER XVIII.

AMPHIBIOLITHI........TORTOISE........CROCODILE.

The *Amphibiolithi* form a very large and important class of fossils, and of which our own country has produced some very interesting specimens. It must, however, be to those of the larger kind that our attention must be directed; since, from their minuteness and extreme delicacy, the remains of frogs, serpents, and of the smaller species of the genus *Lacerta,* are very rarely met with, and then can hardly be expected to afford us any real instruction. The remarks which I shall have to offer will be entirely confined to the *Amphibiæ reptiles*, since I know of no decided instance of the mineralized remains of any of the *A. serpentes.*

The fossil remains of the genus *Testudo* are rarely found, and seldom in such a state as can yield any positive information respecting the original animal. Indeed, when we consider that the sections into which this genus *(Testudo)* has been divided by Linnæus, of the sea, the fresh water, and the land tortoise, are distinguishable by the feet being like fins, or palmated, or club-shaped, with nails, it will be seen that any distinction of this kind can rarely be made in the fossil remains of these animals; since, except in the impression in schist, which will be presently mentioned, no traces of the feet are, I believe, to be found among their fossil remains.

It may not, however, be improper to observe here, that should any remains of this part of these animals be found fossil, they will not serve, with certainty, for the distinctions pointed out by this illustrious naturalist; since subsequent discoveries and observations have shown,

that the habits of these animals do not always accord with the forms of their feet. Thus the curious box-like tortoise, *T. Carolina*, Linn.; *T. clausa*, Bosc, though possessing the feet supposed to belong to the river tortoise, often wanders up into the country: whilst that of Japan, which is organized, in this part, like the sea tortoise, has the habits of the river tortoise.

The hard, bony, and sometimes, perhaps, the scaly covering of these animals, are the only parts which can be expected to be preserved in a mineralized state. But these can so very rarely yield any marks distinctive of species, that any attempts to make out specific differences in these fossil remains must in general be fruitless.

M. Knorr gives the representation of a fossil tortoise, from a very valuable specimen in the possession of Dr. Gesner, found near Glaris. The matrix is a black schist, in which the form of the animal appears to be very strongly marked. Towards the superior extremity, traces of the head are discoverable; and a little on one side the marks of one of its feet extended, and somewhat resembling that of a frog, are also observable.

The back part of a fossil tortoise has been found in the Isle of Malta, *Bocconi Mus. di fisic. et d'experienza*, p. 181. Gesner also mentions the back part of a tortoise having been found in a quarry near Berlin, *De petrifactis*, p. 86; and in the Museum of Dresden was a portion of a fossil shell of a tortoise, seventeen inches in length, and about five inches wide. Some fossil remains found in Aix, in Provence, and which had for some time served to perplex the oryctologists, who had been doubtful whether they should consider them as remains of human skulls, or of nautili, were determined by M. Delatour-d'Aigue, M. Adanson, and M. Lamanon, to be the fossil remains of the tortoise, *Journal de Phys.* T. xvi. p. 468. Fossil remains of these animals have also been found in the neighbourhood of Melsbroeck, near to Brussels, *Oryct. de Bruxelles, par François Xavier-Burtin.* From an examination of these last-mentioned fossils,

Lacepede has thought himself authorized in considering them as belonging to *Testudo marina vulgaris*, of Ray; or *Testudo mydas*, of Linnæus. Camper mentions his possessing the entire back of a fossil tortoise, four feet in length and six inches in breadth, found in St. Peter's Mountain, Maestricht. He speaks also of other remains of the tortoise found in the same part, and particularly of a fossil, similar to his own, in the Museum of John Hunter. *Philos. Trans.* 1786.

The great disproportion existing between the length and breadth of the back of the fossil described by Camper, has also been found to exist in another fossil from the same spot, in the possession of M. Preston, at Liege: it being four feet two inches in length, and only six inches in breadth. This peculiarity of form is considered by Faujas St. Fond, as proceeding from these being the remains of some unknown species of this genus, in which the hard and osseous covering was extended only along the vertebral column, whilst the remaining part of the back was covered with a coriaceous or horny covering, somewhat resembling that of *T. lyra*, Linn. Faujas St. Fond has presented to the Museum of Natural History at Paris the fossil remains of three tortoises from Maestricht. Two of these resemble each other in possessing, different from the ordinary tortoise, two prolongations at the upper angles, as if of the arm, and forming an oval notch, where the head was placed. The third differs from those just mentioned, as well as from the common tortoise, in the general form of its shell; which gives, at first view, the idea of a cuirass, with a double neckpiece or gorget.

M. Faujas St. Fond obtained from the quarry of Grand Charonne part of the shell of a tortoise, which was connected with an alated bony appendix, such as was observed in the remains of the more gigantic tortoises which he found in St. Peter's Mountain. *Ann. du Mus.* Tome II. p. 108.

Reviewing the preceding account, it appears, that all of the six specimens found at Melsbroeck, appear, according to Faujas St. Fond, to belong to *T. mydas*—four specimens from Aix, all belong to one

unknown species—of the eight specimens from Maestricht, which are all unknown, three are ascertained to belong to as many distinct and new species—and the one found in the quarry of Grand Charonne, near Paris, also is of an unknown species. Hence it appears, that of fourteen fossil tortoises, one only appears to be of a known species, and that of the remaining thirteen, none can be referred to any known species, but five of them are decidedly of new species.

In this island the fossil remains of this genus are but rarely met with. In the Isle of Shepey some fragments, and a few very good specimens, have been found. Two or three fossil tortoises from this part, in very fine preservation, are in the British Museum; and Colonel Hawker, of the 14th Light Dragoons, also possesses a very perfect specimen, which he very kindly offered for my inspection and information. Mr. Francis Crow, of Faversham, possesses perhaps the most complete fossil animal of this genus, which has been yet discovered in Shepey.

The specimens which I possess from Shepey do not empower me to decide as to their species. They are of four different sizes, and appear to me to be of the same species, but of different ages. In no one of them is the dorsal plate perfect, surrounded by its marginal scutellæ. Thus, in a very fine specimen, with which I was favoured by Mr. Crow, a series of eight small and narrow hexagonal scutellæ, corresponding with the vertebræ, are disposed along the middle of the back; and from these proceed, on each side, as many transversely long scutellæ, which appear to have been of a hexagonal form; but this cannot be determined, since their outer sides, and of course the margin of the shell, has been removed. From this circumstance, I am led to the supposition, that these are the remains of animals whose coverings were partly soft, and that consequently the marginal plates, if any existed, were removed as the intervening membrane was destroyed. In this opinion I am confirmed by the appearance of the breastplate in one of the specimens, as represented Plate XVIII. Fig. 2; where it may be seen, that the sternal plate, with which, in this respect, the dorsal

plate may be supposed to agree, has not been united, but that it has been connected by interposed membrane. This part happens, fortunately, to be in so good a state of preservation, as to allow the several osseous parts of this plate to be distinctly made out. At *a*, is seen a part of the anterior appendix; at *b*, is the anterior branch; at *c*, the posterior branch; and at *d*, is the posterior appendix.

In Verona, and chiefly in the Valley of Ronca, fragments of tortoise-shell are found; and, from the rugous state of the outer surface of some of these, I have little doubt of their having belonged to some of these animals, whose coverings were partly coriaceous; for in these, although the outer surface of their covering would be smooth whilst living, they would be thus rugous after the death of the animal.

Mr. Johnson, of Bristol, was lately so fortunate as to find, at the Old Passage, in Gloucestershire, some fossils of a very curious appearance and form. One of these is respresented Plate XVIII. Fig. 1. This, with several others, most of which are much larger, and possess a fine polish, and are of a deep black, I conceive to be the digitated terminations of the sternal plate belonging to one of these animals, with a partly membraneous or coriaceous covering. These fossils approach the nearest to the corresponding parts in the *Trionyx carinatus* of M. Geoffroy St. Hilaire. One of the fossils found by Mr. Johnson is decidedly the osseous plate belonging to the posterior appendix, and resembles very much, in its form and rugous surface, the corresponding part in *Trionyx Ægyptiacus*, of M. Geoffroy St. Hilaire, but is full six times as large.

I must not conceal from you, that the ingenious gentleman who possesses these fossils is disposed to entertain a different opinion, and to believe that they are the parts of the jaw or palate of some fish. This must remain to be determined by some more illustrative and analogous specimen: until then, I shall hold my opinion with diffidence; for, as I have had already occasion to notice, error in these inquiries is very easily fallen into. Thus has Faujas St. Fond, in the elegant

work where he has displayed so many remains of these animals, mistaken the shoulderbone of a tortoise for the horn of a stag; fragments of the sternal plates *(plastrons)* of a tortoise for the branched part of the horns of the elk; and two bones of the carpus, belonging also to the tortoise, for the pubis and the clavicle of a crocodile. Similar remains to those found by Mr. Johnson, are sometimes found in the Staunsfield lime-stone.

Plate XVIII. Fig. 3, is the fossil head of a tortoise, found at Shepey by Mr. Crow.

The necessity of ascertaining the number of existing species of the crocodile, and of pointing out their distinctive characters, previous to the examination of their fossil remains, must be obvious; and that this task has been performed by M. Cuvier, who possesses abilities and opportunities so well fitted for the undertaking, is a circumstance which has considerably promoted the advancement of our knowledge in our favourite science. The gratitude due to him, on the present occasion, is considerably augmented by the consideration, that at the period at which his investigations were made, almost every one who had written on the subject had unfortunately contributed, by their errors, to envelope the subject in confusion. M. Schneider, however, had sedulously employed himself, and with some success, in making some useful and important distinctions, with respect to these animals; *Histoire des Amphibies*, cap. II. But the most instructive labours were those of M. Geoffroy, who not only made some important anatomical researches on the crocodile of the Nile, but also on the crocodile of St. Domingo, which bore so strong a resemblance to that of the Nile, as to have led to the suspicion that they were both of the same species; and, of course, to a doubt as to the circumstance dwelt on by Buffon, that no species belonging to the torrid zone had been primitively in both continents. The observations, however, of M. Gregoire, determined that the crocodile of St. Domingo deserved to be regarded as of a different species from that of the Nile. *Ann. du Mus. Nat.* T. I. p. 37 and 53.

This same naturalist suspected, from the accounts he had received, that two distinct species of the crocodile existed in Egypt; one of these he conceived to be the common crocodile of Egypt, and the other the *Suchus*, the sacred crocodile of Thebes. This opinion was strongly corroborated by the skull of this animal, contained in some of the mummies found in the ruins of this celebrated city, and by a well-prepared specimen of an animal of this species. M. Cuvier himself, although doubting as to M. Geoffroy's employing the word *suchus* in the same sense as the ancients did, is satisfied that a difference exists between some of the crocodiles of Egypt, sufficient to allow of admitting the existence of a race, if not a species, distinct from the common crocodile of the Nile.

Aided by the observations of M. Geoffroy, and by the anatomical examination of the crocodile of St. Domingo by M. Descaurtils, who dissected more than forty of this species; and availing himself of the opportunity of examining nearly sixty animals of this genus, of both sexes, and of different ages and sizes, from their passing out of the egg to the length of twelve or fifteen feet, and examining anew the different works which had been written on this animal, M. Cuvier considered himself as anthorized in arranging these animals in the following order :—

The following characters :—conical teeth, in a single row—a broad fleshy tongue, affixed to the mouth—a compressed tail, carinated and serrated on its upper part—palmated or semipalmated feet—and broad and nearly square scales on the back, belly, and tail; he considers as forming the genus Crocodile, of the order *Sauri*, in the class *Amphibia*. This genus he considers as divisible into three sub-genera :— I. Alligators *(caimans)*. The head oblong, but its length being to its breadth not more than as three to two—the fourth lower tooth on each side being received in a pit in the upper jaw—the feet semipalmated. Under this sub-genus he places the following four species: *C. lucius, C. sclerops, C. palpebrosus*, and *C. trigonatus*.—II. Crocodiles. The length of the head double that of its width, the jaws being oblong —the fourth lower tooth on each side passing through a notch on each

side of the upper jaw—the feet palmated. Under this sub-genus he disposes *C. vulgaris*, *C. biporcatus*, *C. rhombifer*, *C. galeatus*, *C. biscutatus*, and *C. acutus*.—III. Longbeaked *(Gavials)*. The jaws elongated and cylindrical—the feet palmated. Under this sub-genus he places the large and small gavial, as *C. gangeticus* and *C. tenuirostris*.

The remains of animals referable to the genus Crocodile, and of others, which though not of this genus, may be considered as of the family of lizards, have been found in a fossil state in different parts of the world, but particularly in this island, in Germany, and France.

In the greatest part of Thuringia and of Voigtland, bordering upon Hesse, and even in Franconia and Bavaria, is a bed of bituminous marl-slate, which Mr. Werner considers as the lowest stratum of the first floetz lime-stone. It is from this bed of schist, in the neighbourhood of Mansfeld, Eisleben, Ilmeneau, &c. that those impressions of fish are obtained, which are so frequently beautified by the brilliant coatings of copper and silver pyrites.

Above this cuprous schist are beds of lime-stone, in which exist belemnites, entrochi, anomiæ, and other remains of high antiquity. On this lime-stone is gypsum, accompanied with sal gem, above which is sand-stone, covered by gypsum, without salt; and on this is another shelly lime-stone, in which are the celebrated caverns, containing the remains of bears and of other carnivorous animals.

The bed of bituminous slate, in which the impressions of fishes, and also of oviparous quadrupeds, are found, are indubitably, from their situation, the most ancient of the strata here enumerated; whilst the fishes, whose impressions are here found, are generally supposed to be those of fresh-water fish; and the oviparous quadrupeds, whose impressions accompany them, are always, according to M. Cuvier, animals which frequent marshes and the banks of rivers. From the representations of four fossil specimens, that by Spener, *Miscell. berol.* I. Fig. 24 and 25, p. 99, from the neighbourhood of Salzungen; that of Link, from the same place, Letter to Dr. Woodward, &c.; that by

Swedenbourg, from Altenstein, *De Cupro Tractat.* Pl. II.; and one from the mines of Rothenbourg, near Saal, at the depth of 264 feet; M. Cuvier was satisfied that the traces here preserved are of animals of the same species.

The form of the head, the pointed teeth, the size of the vertebræ of the tail, would be sufficient, he observes, without the limbs, to show decidedly that this animal must have been an oviparous quadruped. The head, however, does not, as was supposed by Spener and Link, bear any resemblance to that of the crocodile of the Nile. So far, also, is it from being, as is asserted by M. Faujas, a real Gavial, that M. Cuvier is convinced, that it differs more from the Gavial than from any other reptile of the lizard tribe.

From the head engraved by Spener, M. Cuvier was enabled to determine the genus to which this animal belonged. In the upper jaw he could discover only eleven teeth on one side, and which only reached to the anterior angle of the orbit; a circumstance which characterizes the *Lacerta monitor* of Linnæus, or *Tupinambis* of Daudin. In the upper jaw of the crocodile there should be at least fifteen teeth on each side, and these should reach to the middle of the orbit.

The hind feet also, as seen both in Link's and Swedenbourg's specimens, show five unequal toes, of which the fourth is the longest: these toes have the following number of bones in each, beginning with the great toe, and reckoning the metacarpal bone—3, 4, 5, 6, 4. This number, and this proportion of the toes, as well as the number of the joints of each toe, are exactly the same in the *Monitor,* in the common lizards, and in the *iguana;* but are different in the crocodile, which has but four toes to the hind feet, differing but little in their length, and being formed by bones disposed in this number and order—3, 4, 5, 4.

The fore feet are discoverable in the specimen of Link, and have each five toes of nearly equal size. The crocodiles also, as well as the lizards, have five toes to their fore feet, but the little toe is evidently smaller in proportion.

The size of these animals also appears to agree with that of the most common species of *Monitor ;* such as, those which belong to the land, and to the river of Egypt ; that of Congou, described by Daudin ; those of the East Indies, &c. They accord indeed so well, in almost every respect, that M. Cuvier, by comparison with different specimens and skeletons of these animals in the Museum, has been able to detect only one or two apparently specific distinctions. The one of these is, that the spinal processes of the dorsal vertebræ are much more raised than in the Monitors. The other is, that the leg appears to be longer in proportion to the thigh and foot, than is the case in the Monitors.

In the neighbourhood of Altorf, in Bavaria, are quarries of indifferent grey marble, containing ammonites, &c. in which the impressions of large heads, with long jaws, armed with pointed teeth, have been repeatedly found.

The specimens which have been there discovered, have not hitherto warranted the determining with what species of animal, or even hardly with what genus, they should be placed. In the opinion of Merck, *Troisième Lettre sur les Fossiles*, p. 25, the one which he possessed, but which is now in the Museum of Darmstadt, may be considered as a Gavial. Another, in the Museum of Manheim, and which has been carefully figured and described by Collini, *Act. Ac. Theod. Palat.* v. Pl. III. Fig. 1 and 2, is thought, by this author, to have belonged either to a saw or a sword-fish, or to some unknown sea animal. The fore part of another was found by M. Bauder, Burgomaster of Altorf; and this one has been merely described as part of the head of a crocodile.

M. Faujas, who has published figures of the two first of these fossils, agrees positively with Merck in the opinion of their being the heads of the Gavial. This opinion is, however, opposed by M. Cuvier, who has discovered some important points in which they differ. The length of the head at Manheim is to its width as 38 to 11, whilst, in the larger Gavial, the length of its head is to its width as 25 to 9. The general figure of the head also differs from that of the larger

Gavial, it narrowing gradually to form the muzzle. From these two circumstances, and from the long oval marks of the eyes, it would seem to resemble the head of the smaller, whilst its size is nearly that of the larger Gavial. From the figure given by M. Faujas, of the head at Darmstadt, it appears to differ from that of either of the Gavials; since the symphisis of the lower jaw does not extend so much backwards, and there are seven or eight teeth in the separated parts of each branch of the jaw; whilst, in this part of the jaw, in the Gavials, there are only two or three teeth.

Some have imagined these fossils to have been the remains of a dolphin; but that this is not the fact is evinced by the nostrils, which, instead of passing in vertically, at the root of the muzzle, are disposed at its end, and open into a double nasal canal, reaching even beneath the skull. It is evident, that there can exist no reason for supposing that these remains can be referred to any kind of fish; and that they have belonged to some animal of the crocodile kind is certainly the most reasonable conjecture.

Part of the head of a crocodile has also been found in a mountain near to Rozzo, on the borders of Vicentin and of Tyrol, the lower jaw of which is twenty-five inches and a half long, and eight inches wide. Its matrix is a limestone of a yellowish red colour. *Voyage en Tyrol, par M. le Comte de Sternberg*. This fossil has also been referred to the Gavial by M. Faujas; but, as is observed by M. Cuvier, it differs from it in the posterior part of the jaw not being in a straight line with the anterior part, where it is united by the symphisis, but forming an angle, by which the branch of one side becomes separated from that of the other side: a character which sufficiently shows, that this cannot have been the remains of an actual Gavial. M. Cuvier is of opinion, that these fossils, as well as those of Altorf, are the remains of an unknown species of the crocodile, and similar to those which will form the subject of our next letter.

LETTER XX.

FOSSIL CROCODILES.........TWO SPECIES FOUND IN FRANCE, DIFFERING FROM ANY KNOWN SPECIES.........FOSSIL SPECIES FOUND ALSO IN ENGLAND.

THE fossils which we shall now examine will, I doubt not, excite in you a considerable degree of interest; since they have been found in such a state, and in such numbers, as to allow of their comparison with the correspondent parts of animals of the same genus; and since they have been thus compared by M. Cuvier.

These fossils were collected in the neighbourhood of Honfleur, by the Abbé Bachelet, an assiduous naturalist at Rouen, *and were sent, by orders of the Præfect of the department, to the Museum of Natural History!* Similar fossils are also obtained at Havre. They were found in a bed of hard limestone, of a bluish grey colour, which becomes nearly black when wet, and which is found along the shore on both sides of the mouth of the Seine, being in some places covered by the sea, and in others above its level, even at high water.

This bed, M. Cuvier observes, is certainly more ancient than the immense mass of clay which rests on it, and which rises in cliffs of 300 or 400 feet in height, forming the whole of Caux, a part of Auge, and spreads into Picardy and Champagne, and even into England. These bones of crocodiles, as well as those of lizards, in Thuringia, belong, then, to strata considerably anterior to those which contain

the bones of quadrupeds, and which are themselves of very high antiquity; such as the beds of gypsum, at Paris; since these rest on the more common shelly limestone, beneath which is the chalk.

The larger cavities of the bones are filled by the same hard grey limestone; but the pores and smaller cells are filled by a semi-transparent spar, which has sometimes a yellowish tinge. In general a thin coat of pyrites is seen to line the cavity, and, of course, to immediately include the spar: and sometimes the whole of these minute cavities have been filled with pyrites.

The most important specimen in the National Museum is a lower jaw, nearly complete. This jaw, indubitably of a crocodile, is beset with conical striated teeth, with the two sharp edges, one on the fore and the other on the back part, and having the cavities for the germs of the succeeding teeth. In this specimen are also discoverable the sutures which divide each branch of the jaw into six bones. An outline sketch of this jaw is given Plate XVIII. Fig. 7.

That this jaw belonged to some animal of the genus Crocodile, there can be no doubt; and the following differences, noticed by M. Cuvier, as undoubtedly show that this animal could not be of the Gavial species: 1. The branches are much longer, in proportion to the anterior connected part, than in either of the Gavials. 2. The branches do not form so open an angle as in the Gavial; the angle in the Gavial being about 60°, and in the fossil jaw but little more than 30°. 3. From this circumstance, the outer lines formed by the branches, separate gradually from the part where they are united; whereas, in the Gavial, they separate by a sudden and very sensible flexion. 4. The notch which separates the branches penetrates forwarder between the teeth than it does in the Gavial: in the Gavial there are but two or three teeth, and in the fossil jaw there are seven in each branch. 5. The whole number of the teeth is, however, less; in the fossil jaw there are only twenty-two on each side; whilst, in the Gavial, there are twenty-five. 6. There does not appear, in

the fossil the oval hole which exists in the posterior part of the branch, in the known species of crocodiles.

The fossil upper jaw was also ascertained, from different fragments, to differ materially from the upper jaw of the Gavial. The snout, corresponding with the symphisis of the lower jaw, is shorter and flatter than that of the Gavial; and the anterior end terminates in a point, and does not spread out as that of the Gavial does. The anterior edges of the orbits also appear to be more flattened than in the living species. From fair grounds of calculation it also appears, that the skull must have been much longer in proportion to the snout, in the fossil species than in the Gavial.

One of the specimens from Honfleur, a fragment of the base of the symphisis part of the lower jaw, appeared to differ from the lower jaw already mentioned, in being rather flatter; approaching a little, in this and some other respects, to that of the Gavial. This circumstance led M. Cuvier to the suspicion of there being the remains of two species of crocodiles in this stratum.

An attentive examination of the fossil vertebræ confirmed his opinion; since he discovered that the vertebræ also belonged to two different systems of bones, neither of which was similar to that of the known crocodiles. With respect to the first species of fossil vertebræ which he found, he ascertained that the posterior face of the body of the axis, or dentata, is concave, whilst it is convex in all the known crocodiles; a characteristic which is distinguishable in many of these fossil vertebræ, whilst in the known crocodiles this part is convex. Plate XVIII. Fig. 6, represents one of the dorsal vertebræ, in which this circumstance is observable. It is proper to remark here, that whole orders of viviparous quadrupeds, such as the ruminants and solipeds, have the bodies of their cervical vertebræ convex in their fore part; but, in these, their apophyses are very differently disposed. The transverse apophyses in the fossil vertebræ arise by four projecting processes, which give them a pyramidal base; and behind the

surface, receiving the head of the rib, is a deep pit: these are two peculiarities which do not exist in the known crocodiles. In the place, also, of the single inferior spinous apophysis, which exists in the known crocodiles, there are two ridges, each terminating in a tubercle placed forwards. The body of these fossil vertebræ is also more contracted in its middle than is that of the vertebræ of the common crocodile.

The other series of vertebræ also appeared to belong to a crocodile, different from those which now exist, as well as from that whose vertebræ have just been described. Their characteristic differences are: their body is not contracted in the middle, and their transverse apophyses do not arise from the reunion of several projecting ridges. They, therefore, resemble those of the living crocodiles much more than the preceding: but their principal difference, distinguishing them from the preceding fossil vertebræ, as well as from those of the living crocodiles, is that the faces of their bodies are neither of them convex; but are both slightly concave. In other respects, in the disposition of their apophyses, in the suture which connects the annular part and processes with the body of the vertebræ, &c. they agree with the vertebræ of crocodiles in general. A vertebra belonging to this species is represented Plate XVIII. Fig. 5, which answers to the second dorsal vertebra of the common crocodile, by the position of its costal pit *a*, *b*; but differs from it in having no inferior spinous apophysis.

It is undoubtedly exceedingly desirable, to determine to which of these two systems of vertebræ, the fragments of the head and jaws just described may be referred. This is however, at present, hardly possible, the specimens which have been hitherto described not having been found under circumstances which would allow of determining the connection. M. Cuvier, however, thinks it most probable, that the nearly complete jaw belonged to the same animal to which the first described vertebræ belonged; and that the fragment of the jaw which seems to approach nearer to that of the Gavial might be placed with the second species of vertebræ. It must be however observed,

that the vertebræ of the second species were found in the same mass with the large specimen of the lower jaw.

Remains of crocodiles have also been found in other parts of France; as, at Angers and Mans. Some of these remains seem to show, that at least one of the fossil species above noticed is also found in other parts of France besides Honfleur and Havre.

The remains of crocodiles have been also found in different parts of England; but particularly on the coast of Dorsetshire, and of Yorkshire, near Whitby; in the neighbourhood of Bath; and near Newark, in Nottinghamshire.

Dr. Stukeley describes a stone three feet long, and two feet two inches broad, found at Elston, near Newark, in Nottingham. The Doctor described it as containing the marks of sixteen vertebræ of the back and loins, and eleven joints of the tail; nine whole or partial ribs of the left side; the Os sacrum; the Ilium *in situ;* the two thigh-bones a little displaced; with the beginnings of the tibia and fibula of the right leg. On one corner, he thought, the vestiges were to be seen of a foot with four toes; and, at a little distance, an entire toe. The Doctor considered this fossil as the remains of a crocodile or of a porpoise. The stone in which these traces were discoverable, had been used at a well, for placing the vessels on in which the water was obtained. It was of a blue colour, and came probably from Fulbeck quarries, which are on the Western declivity of the long chain of hills which reach through the whole of Lincolnshire, and which contain numerous shells and other marine bodies.*

M. Cuvier considers this fossil to have derived its markings from the remains of a crocodile: that it could not have been from the remains of a porpoise, he observes, is evident, from vestiges of the pelvis, a part which does not exist in the porpoise, being here plainly observable. He discovers also, in this fossil, the square and nearly equal sized

* Phil. Trans. Vol. xxx. p. 963.

spinous processes of the vertebræ; the six anterior vetebræ, with large ribs attached to them, and three ribs at the end of the stone, the vertebræ belonging to which are broken off. The five vertebræ next to those which are connected with the ribs, he remarks, have large transverse processes, whilst those of the next four are small. The ilia are situated after these four; but he is of opinion that they have been displaced, and that they should have been found behind the five vertebræ with large transverse processes, which he considers as vertebræ of the loins. The impressions of the ossa ilia were supposed by Stukeley to have been of the thigh-bones; and two large and short impressions near them, which M. Cuvier is unable to refer to any particular bones, he considered as the heads of the tibia and fibula. No marks of the head existing in this fossil, and the vertebræ not having been figured with precision, no conjectures can be offered with respect to the species.

Captain William Chapman, in the fiftieth volume of the Philosophical Transactions, p. 688, gives an account of the finding, on the sea-shore, about half a mile from Whitby, part of the bones of an animal appearing to have been an alligator. They were found in a kind of black slate, which had been covered five or six feet with water every full sea, and were about nine or ten yards from the cliff, which is nearly perpendicular, and about sixty yards high, and is continually wearing away by the washing of the sea against it. The place where these bones lay was frequently covered with sea-sand to the depth of two feet.

Mr. Woolers, p. 786, of the same volume, gives a further account of the foregoing fossil skeleton. He says: "In this same rock, ammonitæ, or snake-stones, as they are called, are found. The animal, when living, must have been twelve or fourteen feet long. It lay six yards from the foot of the cliff, which is sixty yards in perpendicular height, and must have been covered by it, probably, not much more than a century ago. The cliff there is composed of various strata,

beginning from the top of earth, clay, marle, and stones, of various thicknesses, till it comes to the black slate, or alum rock ; and about ten or twelve feet deep, in this rock, this skeleton laid horizontally. The probability of this cliff formerly covering this animal, and extending much more into the sea, is not in the least doubted of by those that know the cliff. The various strata which compose it are daily mouldering and falling down; several thousand tons often tumbling down together. Many ancient persons now living remember this very cliff extending, in some places, twenty yards further out than it does at present, so much has the sea gained of the land."

From the figure of this fossil, as given in the Philosophical Transactions, Plate XXII. and Plate XXX. of the same volume ; and, from the description, it appears that the remains and traces were observable of a vertebral column, probably, however, not complete at either end, nine feet in length. Twelve vertebræ of the tail, and a series of ten other vertebræ, which seemed to have formed the loins, sacrum, and the commencement of the tail, still remained, and were about three inches in length. Those of the neck, of the back, and the middle of the tail, had only left their impressions. The head is seen on its lower side, showing the occipital condyle on the back part; the zygomatic arches, on each side, terminating, as in the crocodile, in two large condyles for the lower jaw, and placed in the same transverse direction with the occipital condyle. The skull fills but a narrow space. Forwards, the head contracts not suddenly, as in the Gavial, but gradually; and, in M. Cuvier's opinion, like the fossil head of Altorf; and probably, like that of Honfleur, in a pointed muzzle. Large pointed teeth are placed alternately in both jaws, about three quarters of an inch distant from each other ; and towards the end of the jaws are fangs which are larger than the others.

It is extraordinary, that the celebrated Camper should have concluded this fossil to have been the remains of an animal of the species *Balæna*, when teeth were observable in both jaws, whilst the balænæ

are not furnished with any teeth. Nor is it less surprising that M. Faujas should have considered this fossil as belonging to a physeter, and describe it as being without arms or legs*, since the physeters have teeth in the lower jaw only; and since, in this fossil, the traces both of the fore and hind legs were discoverable.

From the researches which M. Cuvier has made, respecting the fossil remains of this animal, he concludes, that at Honfleur and Havre the fossil remains of two species of crocodiles are found, both approaching to the Gavial, but both unknown; that one of these two species at least is found in other parts of France, at Alençon and elsewhere; that the skeleton discovered at Whitby was probably of one of that species found in France, the under jaw of which he has figured; that the fragments of the heads found in the territory of Vicentino may be referred to the same species; that the fossil heads found at Altorf are different from those of the Gavial, and have a longer snout than that of the animal of Honfleur, whose jaw is figured, and may therefore belong to the other fossil species found in France; that the skeleton described by Stukeley is a crocodile's, but of an indeterminable species; that the supposed crocodiles, the remains of which are found in the pyritous schist of Thuringia, were of the genus *Monitor*, Cuvier, formed of *Lacerta monitor*, Linn.

He also concludes, that all these fossil remains of oviparous quadrupeds belong to very ancient beds, among those which are termed secondary; and even much anterior to the regular stony beds, which contain the bones of unknown genera of quadrupeds, such as the palæotheriums and the anoplotheriums; which opinion, however, does not oppose the finding of the remains of crocodiles with those of these genera, as has been done in the gypsum quarries.

The opportunities which I have had of examining British fossils of this kind, have not been such as to enable me to add to the very im-

* Essais de Geologie, I. p. 360.

portant information yielded by M. Cuvier, as to the specific differences of such of these animals as have been found in a fossil state. The observations, however, which I have been able to make, are such, as far as they extend, as serve to confirm the opinions of M. Cuvier.

Several fragments, which I have seen, from the Dorsetshire coast, as well as those which I possess, show, that the anterior termination of the snout of one species of these fossil animals, whose remains are found in this island, was long and narrow, like that of the first species described by M. Cuvier. Three other specimens which I have seen, one containing almost the whole skull, and the others the anterior part of the skull, and all having the posterior part of the branches of the lower jaw attached to the upper jaw, manifest decidedly the same gradual approximation of the branches of the lower jaw, which we have seen distinguishes this fossil species from all the known species of the sub-genus Gavial. The first of these was exhibited in the London Museum; and, of the latter two, one was in the possession of the late Mr. Row, of Dorsetshire, and the other was exposed for sale by auction. These specimens were all British fossils; and evinced, by the form of their anterior part, that they had derived their origin from the same species of animal to which the specimens above mentioned had belonged. The union of these specimens prove therefore decidedly, that in this island, as well as on the continent, there exist the remains of a species of crocodile, approaching towards, but essentially differing from, any known species of the Gavial. Of the head of the second species, no specimen which I have seen affords me any positive information.

Of the two species of vertebræ described by M. Cuvier, I only possess specimens corresponding with those which he supposes to belong to the second species which he has particularized. Two detached vertebræ, which are, I conjecture, from Bath; three which are disposed in their natural order, and imbedded in the Dorsetshire blue limestone; and several others, in the same limestone, the sections

of which are only seen, are all referable to this second species; both of their articulating surfaces being slightly concave.

Somersetshire, particularly in the neighbourhood of Bath, the cliffs on the Dorsetshire, or Southern coast, and on the Yorkshire, or Northern coast, are the places in this island in which the remains of the animals of this tribe have been chiefly found. The matrix in which they are found is in general similar to that which has been already mentioned, as containing the fossils of Honfleur and Havre: a blue limestone, becoming almost black when wetted. This description exactly agrees with the limestone of Charmouth, Lime, &c. in Dorsetshire, on the opposite coast to that of France, on which Havre and Honfleur are situated. At Whitby and Scarborough, where these fossils are also found, the stone is indeed somewhat darker than in the former places; but no difference is observable which can be regarded as offering any forcible opposition to the probability of the original identity of this stratum, which is observed on the Northern coast of France, on the opposite Southern English coast, and at the opposite Northern extremity of the island. Some of these remains are also found in quarries of common coarse grey and whitish limestone. Instances of this kind of matrix, for these remains, are observable in the quarries between Bath and Bristol.

The Rev. Mr. Hawker, of Woodchester, in Gloucestershire, possesses, perhaps, one of the handsomest specimens of the remains of the crocodile that has been found in this island. It was found by him in the neighbourhood of Bath, and contains great part of the head and of the trunk of the animal, which appears to have been of the species noticed by Cuvier, with the gradually tapering jaw.

LETTER XXI.

LARGE FOSSIL ANIMAL OF MAESTRICHT........ASCERTAINED TO BE NEITHER PHYSETER, FISH, NOR CROCODILE........OPINIONS OF DR. PETER CAMPER, M. FAUJAS, M. ADRIAN CAMPER, &C....REMAINS OF THE EXISTING MONITORS.......ENGLISH SPECIMENS.

The large animal, whose fossil remains are found in the quarries of Maestricht, has been deservedly a frequent object of admiration; and the beautiful appearance which its remains possess, in consequence of their excellent state of preservation, in a matrix which admits of their fair display, has occasioned every specimen of this fossil to be highly valued. The lower jaw of this animal, with some other specimens which were presented by Dr. Peter Camper to the Royal Society, and which are now in the British Museum, are among the most splendid and interesting fossils in existence. A particular account of these fossils, with the opinions of the learned donor respecting the animal to which they belonged, and some excellent engravings, are given in the Philosophical Transactions for 1786.

The remains of this animal are found chiefly in that part of St. Peter's Mountain, on which is built the fort St. Peter. Whilst speaking, in a former part of this work, of the alcyonic fossils from this mountain, I remarked that their matrix was "a very pure carbonate of lime." M. Cuvier has also ascertained this to be the case, and that the description of it by M. Faujas, who says it is "*Un gres quartzeux à grain fin, foiblement lié par un gluten calcaire peu dur**," is erroneous. The mass of calcareous matter in which they are imbedded is at least 449 feet in thickness.

* Hist. Nat. de la Mont de St. Pierre, p. 14.

The first collection of these fossils was made by an intelligent officer, M. Drouin, who commenced his researches about the year 1766. This collection is at present in Teyler's Museum. M. Hoffman, the surgeon of the fort, of whom I have already spoken, also made a collection of these specimens, which at his death was purchased by Dr. Peter Camper, who presented some of them, as has been already related, to the British Museum.

In 1770, the workmen having discovered part of an enormous head of an animal imbedded in the solid stone, in one of the subterranean passages of the mountain, gave information to M. Hoffman, who, with the most zealous assiduity, laboured until he had disengaged this astonishing fossil from its matrix. But when this was done, the fruits of his labours were wrested from him by an ecclesiastic, who claimed it as being proprietor of the land over the spot on which it was found. Hoffman defended his right in a court of justice; but the influence of the Chapter was employed against him, and he was doomed not only to the loss of this inestimable fossil, but to the payment of heavy law expenses. But in time, justice, M. Faujas says, though tardy, at last arrived—the troops of the French Republic secured this treasure, which was conveyed to the National Museum.

This fossil is described by M. Faujas, in his work on the Mountain of St. Peter. In this work M. Faujas endeavours to show that this animal must have been a crocodile, in agreement with the opinion of Messrs. Drouin and Hoffman, and in opposition to that of Dr. Peter Camper, who believed it to have been a cetaceous animal. M. Adrian Camper, after the most careful investigation, has thought it must have been a reptile, allied, in some respects, to the family of Monitors, and in others to the Iguanas.

Furnished by M. Loisel, Præfect of the Lower Meuse, with numerous other specimens, not only from the quarries under Fort St. Peter, but from several other hills, and particularly from the village of Seichem, in addition to those which had been secured by M. Faujas,

the indefatigable Cuvier proceeded to a careful anatomical examination of these specimens, with the hope of furnishing some information respecting their origin. This undertaking he conceived to be more particularly necessary, since the splendid work of M. Faujas contains no really illustrative osteological remarks; and since M. Faujas considers M. Adrian Camper as being of the same opinion with him, as to the agreement of this fossil animal with the crocodile; whilst the animal to which the latter gentleman refers this fossil is essentially different from the crocodile, although placed by Linnæus with it, under the genus *Lacerta*.

To M. Adrian Camper we are indebted for the knowledge of the real characters of this enormous animal, known only at present as a fossil. By the observations of this gentleman, corroborated by those of M. Cuvier, which I shall now place before you, I trust you will be fully satisfied respecting the original nature of this wonderful animal.

Dr. Peter Camper had been led to the conclusion, that this animal should be placed among the cetaceous animals; 1st, from its being accompanied by marine remains; 2dly, from the bones being polished; 3dly, from the lower jaw having, externally, numerous openings for the passage of the nerves; 4thly, from the roots of the teeth being solid; 5thly, from there being teeth on the palate; 6thly, from the vertebræ being without sutures; and, 7thly, from the phalanges and ribs being of a different form from those of the crocodile.

All these circumstances, except the first, are allowed by M. Cuvier, to prove that this animal was not a crocodile; but he does not admit that any of them prove its having been a whale; since, in several reptiles, and particularly in the monitors and iguanas, the bones are polished, numerous openings exist in the lower jaw, the roots of the teeth are bony and sold, and the vertebræ are without suture. The fifth circumstance proves also, that the animal could neither be a cetaceous animal, nor a crocodile, since none of these animals have teeth in the palate.

Dr. Camper, whilst distinguishing this fossil animal from the cro-

codile, observes, that in the fossil jaw-bones of St. Peter's Mountain, a small secondary tooth is formed, with its enamel and solid root, within the bony substance of the primordial tooth itself. These secondary teeth, by continuing to grow, seem to make, by degrees, sufficient cavities in the bony roots of the primary teeth; but what becomes of them at last, and how they are shed, he adds, I am not able to guess*.

From the existence of a hollow in the primary teeth of the fossil animal, and from the growth of the secondary tooth in this hollow, M. Faujas is led to exclaim: "It is difficult to conceive how this illustrious philosopher could permit so striking a character to escape him; and, after witnessing this circumstance (the secondary tooth being formed near the centre of the bony support of the primary tooth), how he could conceive these teeth to belong to a cetaceous animal†." The approximation of the secondary towards the centre of the primary tooth appears, however, in this animal, to have been merely an accidental occurrence. Nor does it appear that the mode of dentition at all coincided with that which is known to take place in the crocodile.

On this subject M. Cuvier observes, that in the crocodile the tooth is always hollow; that it is fixed in, but never attached to, the bone of the jaw; and that the secondary tooth forms in the same socket, and frequently grows into the hollow of the primary tooth, thus shivering it, and occasioning it to be shed.

The fossil animal of Maestricht, he remarks, on the contrary, like other animals, appears to have had its teeth hollow only whilst they were growing, they afterwards filling up, and becoming solid and fixed in the jaw by a fibrous and osseous substance, materially differing from the real substance of the teeth, although closely united with it. The secondary tooth, too, is here formed in a particular socket, which is formed at the same time with this tooth, which passes out, sometimes at the side, and sometimes through the osseous substance which supports the primary tooth. In the end, it detaches this substance

* Philos. Trans. for 1786, p. 178. † Hist. Nat. de la Mont. de St. Pierre, p. 240.

from the jaw, occasioning it to fall off, by a species of necrosis like that by which the horns of stags are separated; the secondary tooth, and the osseous body which supports it, filling the place of the tooth which has been expelled. The cellular and osseous body supporting the teeth, and which have been erroneously assumed by M. Faujas, as well as by others, as the root of the tooth, appears to be the pulp of the tooth; which instead of remaining pulpy, as in quadrupeds, ossifies, and performs the office of a root, becoming one body with the bony socket.

This mode of organization and of dentition sufficiently distinguishes this animal, therefore, from the crocodile, and indeed displays further proofs that it cannot be considered as a cetaceous animal: M. Cuvier is, therefore, induced, to place it between the osseous fishes and the iguana and tupinambis.

To enable you to form a better judgment respecting the opinions of M. Cuvier, to which I shall now call your attention, I have given, Plate XIX. Fig. 1, a copy of the engraving of the large head of this animal, from Plate XIX. Vol. XII. of *Annales du Museum*, &c.

a, *b*...........The left side of the lower jaw, nearly whole, and seen on its outer side.

c, *d*...........The right side of the lower jaw, seen on its inner side, the posterior part of which, a little concealed by the palate-bones, is continued to *e*.

f, *g*...........The right side of the upper jaw, seen on its inner side, and with the palate. This jaw has nearly kept its natural situation, with respect to its preceding bone.

h, *i*...........A fragment of the left side of the upper jaw, displaced and fallen on the lower jaw.

k, *l*, *m*, *k′*, *l′*, *m′*, *o′*, The two palate-bones, displaced and thrown one over the other, and also over the right side of the lower jaw.

In the original specimen, a portion of bone is placed from *m* to *p*, and another at *q*, which are omitted; as, being mutilated, they cannot be made out, and conceal the more instructive pieces.

In the lower jaw are fourteen similar teeth on each side, but the monitors have only eleven or twelve; and the crocodiles have fifteen, which are very unequal. In this jaw also are from ten to twelve large and pretty regular holes. In the *Monitors* are six or seven, and in the *Crocodiles* a considerable number of small and irregular openings; whilst in the *Dolphins* there are but two or three, which are towards the end.

At *p* is an obtuse raised coronoid apophysis, the anterior ridge of which is enlarged, as in the monitors. In the crocodiles there is nothing similar, in the dolphin it is smaller and much backwarder, and in the iguana it is more pointed. The articulating surface, *r*, is concave, and very near the posterior end, as in all the lizards; but it is lower than the dental edge, as in the monitors; in the crocodiles, and in the iguanas, it is higher. In the dolphins it is convex, and placed quite at the end. The apophysis *b*, for the attachment of the muscle analogous with the digastric, is short, as in the iguana; in in the crocodile it is longer; and still more so in the monitor.

The formation of the lower jaw shows that this animal more nearly accorded with the monitors than with any other of the lizard tribe: as to the cetacea, there exists no resemblance; since in these, as in all the mammalia, each side of the lower jaw is in one piece. But to be convinced of the closer agreement of the lower jaw of the fossil animal with that of the monitor than with that of the crocodile, it is necessary to attend to the following comparison.

In the lower jaw of the crocodile are six bones on each side: the *dental*, in which are formed the alveoli of the teeth, the two being articulated with each other, in the fore part, and forming the anterior angle; the *opercular*, which forms almost all the inner surface of the jaw, except on the fore part where it is formed by the dental; the *coronoidal*, with the *angular;* the former placed over the latter, reaching to the posterior extremity; leaving between them a space in the fore part, which is occupied forwards by the end of the dental,

and forms in the back part a large oval hole. The angular bone curves upwards, to occupy a space in the inside of the jaw. Between this bone and the opercular is another oval hole, smaller than the preceding; and above that a void, in consequence of the coronoidal not turning towards the inner surface: the anterior point of this space is bordered by *a small bone of a crescent form.* The condyle, all the superior surface of the posterior apophysis, and all the internal surface of this part, belongs to the *articular* bone. In the crocodile there is no sensible coronoidal apophysis.

The lower jaw of the monitor is composed of the same number of bones as in the crocodile; but, in the monitor, the angular is much shorter and narrower, and the coronoidal terminates as if truncated, where it unites with the dental; the large oval hole not being left between them, which is observed in the crocodile. The coronoid apophysis is formed by the bone which, in the crocodile, is termed the crescent bone. The articular bone alone forms the posterior apophysis; and joins, with its internal surface, the crescent, and carries to the upper edge of the bone the opening for the entry of the maxillary nerve, which opening is so large in the crocodile. In the monitor, also, there is no opening in the inner surface between the opercular and the angular bone; but there is a small one in the opercular itself, and a larger one between that bone and the dental.

In the lower jaw of the animal of Maestricht, of which the coronoidal apophysis is seen at *s*, the angular bone at *t*, and the dental at *u* and *y*, there is no large oval hole in the external surface; the coronoid process is a distinct bone, analagous with the crescent-formed bone; the articular bone alone forms the posterior apophysis, and disposes the angular much forwarder; the coronoidal unites with the dental bone in a straight transverse suture; and there exists a small opening in the opercular bone.

This animal, therefore, approaches the nearest to the monitor, nearer even than to the iguana, in the conformation of the lower jaw,

as well as in the structure, figure, and insertion of the teeth; although, in this latter respect, there exists a peculiarity in the fossil animal.

In the monitor, as in the iguana, the teeth simply adhere to the internal surface of the two jaws, without the maxillary bone rising to form sockets round them; but in the fossil animal, the feet, or bony nuclei, which sustain the teeth, are adherent in the cavities, or real sockets, formed in the thickness of the edge of the jaw.

In the fossil upper jaw are eleven teeth; but, as the intermaxillary bone appears to have been removed, and as it might have contained three teeth, as in the monitors, it most probably contained the same number in the upper as in the lower jaw. The water-monitor of Egypt has fourteen at the top, but only twelve at the bottom.

In the fossil animal all the teeth are pyramidal, and a little bowed; their outer surface is flat, and is separated, by two sharp ridges, from the inner surface, which is round, or rather semi-conical. Some of the monitors have conical teeth, and others have them rather flat and edged; all the iguanas, and even the lizards and ameiva, among which may be reckoned the pretended tupinambis, or monitor of America,* have teeth with dentated edges.

Thus far, then, the fossil animal of Maestricht appears to approach nearer to the monitors than to any others of the lizard tribe; but a further examination, at once, shows a remarkable variance of character; the palate-bones being armed with teeth, which at once approximates it to the iguanas.

M. Cuvier has, by his rich resources in comparative anatomy, been enabled to determine that the crocodiles, the monitors, the common lizards, the dragon of Lacepede, the *dracena* of Linnæus, the *ameiva*, *draco*, *stellio*, *agama*, *basiliscus*, *gecko*, *camæleo*, *scincus*, and *chalcides*, are without teeth on the palate-bones. The iguana and

* This American monitor differs from those of the old continent, and approximates nearer to the common lizards, by its teeth, with dentated edges, and by the square scales of its belly, tail, &c.

the anolis only, among the lizards, agree with many of the serpents, batracii, and fishes, in possessing these peculiar weapons.

But the serpents have them on both their anterior and posterior palate-bones; the frogs and *hylæ* on a transverse line on the anterior; the iguanas and salamanders lengthwise on the posterior; many fishes, such as the pike, salmon, and genus *Gadus*, have them also lengthwise. This circumstance had somewhat misled P. Camper and M. Van Marum. Comparison will, however, show that the bones in the fossil animal in which these teeth are implanted, resemble those of reptiles, and not those of fishes.

In the monitor and the iguana, the bone which M. Geoffroy calls the posterior palatine, and which M. Cuvier considers as the internal pterygoidal apophysis, is not, as in the crocodile, united with the sphenoidal bone, nor enlarged into a large triangular plate. It is here a bone with four branches, one of which extends forwards, and unites with the anterior palatine; the second passes to the side, to join the bone called, by M. Geoffroy, the alar bone, which unites itself with the superior maxillary bone; the third rests, by a surface covered by a cartilage, on an apophysis of the base of the skull; and, lastly, the fourth extends backwards, and gives attachment to muscles, but does not articulate with any bone.

It is on the inner edge of the anterior branch that the series of teeth is implanted which distinguish the iguana. The anolis has this bone wider in all its parts, and the posterior branch shorter, but it in other respects resembles that of the iguana. In the monitors, on the contrary, all the parts of this bone are narrower, and it is without teeth.

Now, viewing the palate-bones of the fossil animal, all the parts are directly seen, which have been just described as existing in the iguana. The one which is in the upper part, *k*, *l*, *m*, is that of the right side. Its external apophysis, *o*, is concealed, but the posterior, *l*, although broken at the end, shows plainly that it must have been as long in proportion as in the iguana. The other, *o′*, *k′*, *l′*, *m′*, is that of the right

side: it shows the four apophyses very distinct. The chief specific difference which it shows is, that the internal process, *m*, is longer than in the iguana, or in the monitor. Each of these bones, in the fossil animal, appears to have borne eight teeth, which grew, were fixed, and were renewed in the same manner as those of the jaws; but which were, of course, much smaller.

We have, therefore, now sufficient grounds for assuming a place for this fossil animal. Its head fixes it irrevocably between the monitors and iguanas. But how enormously must its size have exceeded that of all the iguanas and monitors now known! None of them have a head longer, perhaps, than five inches; whilst, in the fossil animal, it must have been nearly four feet.

Prepared by the knowledge he had obtained, respecting the head of this animal, M. Cuvier proceeded with confidence to the examination of the vertebræ. P. Camper had given a figure of one of the vertebræ of this animal, under the impression of the animal being one of the cetacea; and M. Faujas has given four plates of them, as belonging to a species of the crocodile. But M. Cuvier, aided by an important series of specimens, found at Seichem, a village about two leagues from Maestricht, and by a memoir of M M. Minkelero and Herman, which accompanied the specimens, has been enabled not only to point out the several kinds of vertebræ, and to compare them with the analogous vertebræ in existing animals, but even to point out, with a high degree of probability, their succession, and the number of each sort composing the spine.

All these vertebræ, like those of crocodiles, monitors, iguanas, and the greater part of the lizard and serpent tribe, have their bodies concave in their fore part, and convex on their posterior part; which distinguishes them decidedly from those of cetacea, in which they are nearly flat; and still more from those of fishes, in which the two ends are hollowed into conical cavities. The concavities and convexities of these vertebræ are, as in all similar vertebræ, more strong in the anterior than in the posterior vertebræ.

The apophyses establish, by their number, five kinds of vertebræ. The first sort, the last of the neck and the first of the back, have a superior spinous apophysis, long and compressed ; an inferior, terminated by a concavity ; four articular, the posterior of which are short, and are directed outwards ; and two transverse, which are thick and short. Their bodies are longer than wide, and wider than high ; their faces are transversely oval. Those of the middle of the back have not the inferior apophysis, but resemble the preceding in every thing else. The last of the back, those of the loins, and of the beginning of the tail, have no articular apophyses, and their places may be known by their transverse apophyses, which become elongated and flattened. The articular surfaces of the posterior of these vertebræ are nearly triangular. The next of the tail, besides their superior spinous apophyses, and the two transverse, have at their inferior side two small surfaces to receive the angular bone*, *(l'os en chevron)*. The articular surfaces of these vertebræ are pentagonal. The next set, Plate XVIII. Fig. 8, differ from the preceding in not having any transverse apophyses. These form a large part of the tail. The angular bone, *a*, is not here articulated, but united into one body with the vertebra. The succeeding vertebræ become more and more compressed at the sides ; and, as they approach the end of the tail, cease to have any apophyses at all.

This series of vertebræ gives opportunity to M. Cuvier to offer some important observations. The angular bone first claims his attention. Its great length, with that of the spinous apophysis, which is opposite to it, sufficiently prove that the tail of this animal was considerably extended vertically. The absence of the transverse apophyses from a considerable part of the length of the tail, prove, at the same time, that it was much flattened at the sides. Hence he concludes, that this animal was aquatic, and swam in the manner of the crocodile,

* That which I have termed angular bone, and which is by the French designated by the term *l'os en chevron*, is a bone, of which several are sometimes placed at the junctures of the vertebræ of the tail on their lower part, where they are disposed so as to form an angle, as in the letter V.

working its vast tail, as an oar, from side to side, and not upwards and downwards, as in the cetacea.

In the monitors the tail is rounder, and the transverse apophyses reach much further. In the crocodiles, the basilisks, the lizards, the stellions, and in the lizard tribe in general, except the monitors, and even in the cetacea, and in all the quadrupeds with a large tail, the angular bone is articulated on the lower part of the joining of the vertebræ, and is therefore common to two vertebræ.

The monitors alone have beneath the body of each vertebra two surfaces for its reception, as in this animal; only the body of their vertebræ being more elongated, these surfaces are on them placed more posteriorly. In the fossil animal, these surfaces are near the middle. But M. Cuvier observes, that he does not know any animal, in which the angular bone is united in one body with the vertebra, as it is in this, through the posterior part of the tail, by which its solidity is of necessity much augmented.

Another character, distinguishing the fossil animal from the monitors, and from others of the lizard tribe, is the sudden ceasing of the articular apophyses of the vertebræ, which takes place in the middle of the back, whilst, in the greater part of animals, they extend very nearly to the end of the tail.

The first twenty vertebræ of the tail appear to have had no angular bones attached to them; whilst, in the crocodile and monitors, only one or two vertebræ of this description exist. Hence the tail of this animal must have been in all probability, cylindrical at its base, and have enlarged in a vertical direction, and become flattened, only at some distance from the body, assuming the form of an oar much more than is the case in the crocodile.

Besides other differences between these vertebræ and those of the crocodiles, it is observable that those of the neck, in the fossil, do not possess the two tubercles which, in the crocodile, bear the little false rib on each side; which is another proof that this animal was not a crocodile, and that it possessed more liberty of moving its head from side to side.

By the vertebræ found at Seichem, which appeared to be of one and the same spine, and by the memoir of M. Herman, M. Cuvier found himself able to determine the absolute number of the vertebræ of each sort.

The number of the vertebræ of the neck, back, and loins, without reckoning the atlas and axis, he concludes to have been twenty-nine; and supposing the two last of the number to have belonged to the pelvis, they would be twenty-seven, precisely the same as in the monitors, in which animal, four of the neck, and two of the loins, are without ribs. There are, therefore, in the monitors, twenty-three pair of vertebral ribs; whilst the crocodiles have but seventeen, even when counting the five little false cervical ribs; and it is very probable that the fossil animal had twenty-two or twenty-three at the least.

The number of the vertebræ of the tail appears to have been ninety-seven. This number much exceeds that of the crocodile, which has but thirty-five: but they very little exceed those of the monitor, M. Cuvier having found seventy-nine caudal vertebræ in a skeleton of this animal, in which some were known to be wanting.

The length of the cervical, dorsal, and lumbar vertebræ, appears to have been about nine feet five inches, and that of the vertebræ of the tail about ten feet; adding to which the length of the head, which may be reckoned, considering the loss of the intermaxillary bones, at least at four feet, we may safely conclude the whole length of the skeleton of the animal to have approached very nearly to twenty-four feet.

The head is a sixth of the whole length of the animal; a proportion approaching very near to that of the crocodile, but differing much from that of the monitor, the head of which animal forms hardly a twelfth part of the whole length.

The tail must have been very strong, and its width at its extremity must have rendered it a most powerful oar, and have enabled the animal to have opposed the most agitated waters, as has been well remarked by M. Adrian Camper. From this circumstance, and from

the other remains which accompany those of this animal, there can be no doubt of its having been an inhabitant of the ocean.

The fossil remains of the extremities of this animal appear to have been so rarely found, that M. Cuvier, at one time, was led to suppose that it had none. M. Faujas has however given, *Mont. de S. Pierre*, Pl. XI. under the name of *Scapula*, the figure of a *pubis*, which very nearly resembles that of a monitor. Among the specimens sent from Seichem, M. Cuvier found a portion of a real shoulder-blade, much resembling, in its form, that of the monitor's, but very different from the narrow shoulder-blade of the crocodile, or from that of the iguana. It is right to observe that the bone represented by M. Faujas, *Mont. de S. Pierre*, Pl. x. is merely the humerus of a large tortoise.

P. Camper, as well as his son, speak of, but neither figure nor describe, a bone of the carpus and of the phalanges: M. Cuvier, who has not seen any of these bones, thinks we may, however, be allowed to conjecture, from the agreement of the teeth and vertebræ with those of the monitor's, that this animal had five toes; whilst, from its being a marine swimming animal, we have reason to suppose, that neither its toes nor hind feet were so elongated as in those reptiles, which are for the most part terrestrial.

Taking all these circumstances into consideration, M. Cuvier concludes, that certainly on fair, if not indisputable grounds, that this animal must have formed an intermediate genus between those animals of the lizard tribe, which have an extensive and forked tongue, which include the monitors and the common lizards, and those which have a short tongue and the palate armed with teeth, which comprise the iguanas, marbrés, and anolis. This genus, he thinks, could only have been allied to the crocodile by the general characters of the lizards.

The history of this wonderful fossil gives us, then, an instance of an animal far surpassing, in its size, any of the animals of those genera to which it approaches the nearest, in its general characters: at the same time that, from its accompanying fossils, we find reason to be-

lieve it to have been an inhabitant of the sea, whilst none of the existing lizard tribe are known to live in salt water. These circumstances, however wonderful as they are, are more than equalled by many of the numerous discoveries which we have yet to contemplate in the natural history of the former world. We have here seen a monitor possessing the magnitude of a crocodile; but we have yet to examine a tapir of the size of an elephant, and a sloth (the megalonix) as large as a rhinoceros.

We have seen, in the preceding letter, that the remains found in the pyritous schist of Thuringia were referable to *Lacerta monitor*, Linn. or rather to some species of the genus *Monitor*, of Cuvier; and this we shall find to be the case with other supposed remains of crocodiles.

Spener, in 1710, published, *Miscel. berolin*. I. Fig. 24 and 25, a plate, representing a supposed fossil crocodile. This fossil was found at the depth of three hundred feet, in the mines of Kupfer-Suhl, near to Eisenach, in Prussia. In 1718, Linck, of Leipsic, published the letter already mentioned, to Dr. Woodward, describing and figuring a supposed fossil crocodile, of which he says:—" Non terrebit musas tuas hic crocodilus, acutissime Woodwardi. Neque enim e Nilo canibus hominibusque formidandus, sed ex mediis Germaniæ montibus venit." Another fossil was particularized by Swedenborg, *Tractat. de Cupro*, Pl. II. found in the mines of Glucksbronn, near to Altenstein, and was placed by Swedenborg among the apes, he supposing it to have been a species of *Guenon* or *Sapajou*. Another fossil of this kind is one which was found in the mines of Rothenbourg, at the depth of two hundred and sixty-four feet, but is at present in the Royal cabinet of Berlin.

These fossils, all of the same character and size, and found in a similar matrix, appear to belong to one species of animals. The form of the head; the teeth, all sharp; and the size of the vertebræ of the tail; determine it to be an oviparous quadruped, without the proof of the posterior members, which afford full confirmation.

Spener's fossil was supposed by him to be a crocodile; and Faujas

has gone so far, as to determine it to be actually a Gavial; but his error is at once proved, by the shortness of the muzzle. Cuvier, on the contrary, shows that this head alone determines the genus of this animal. If it had been the head of a crocodile, there must have been at least fifteen teeth in the lower jaw, and seventeen or eighteen in the upper jaw; and which would have reached to beneath the middle of the orbits: but in these fossil remains there have been but eleven, which stop at the anterior angle of the orbit. These are the characters of one of the numerous species which have been heaped together by Linnæus, under the name of *Lacerta monitor*, and distinguished by Daudin by the inappropriate generic name *Tupinambis.*

In the fossil of Swedenborg, the hind feet, the impressions of which are well preserved, show five unequal toes, of which the fourth is the longest These are formed of the number of small bones, and in the order here set down, beginning with the thumb, and including the metacarpal bones—3, 4, 5, 6, 4; but in that species of ape *Guenon*, or *Cercopithecus*, the number and order would be 3, 4, 4, 4, 4, and the third toe the longest. In Linck's specimen the same series is discoverable as in Swedenborg's.

Hence it appears, that the number and order of the toes, as well as the number and order of the articulations of each toe, of this fossil animal, precisely agree with those of the monitor, as well as of the common lizards and of the iguana; but not at all with those of the crocodiles, which have on their hind feet but four toes, differing but little in length, and the number and order of bones being 3, 4, 5, 4.

In the fore feet of the fossil animal five nearly equal toes may be made out. This agrees with those of the crocodile and lizards, but in these the last toe is evidently smallest.

The length of the fossil animal appears to have been about three feet, which is about the size to which the monitors of Egypt, of Congou, and of the East Indies, generally attain. Of these fossil animals having, therefore, belonged to some species of animals

which have been confusedly ranged by Linnæus under the species *Lacerta monitor*, and of which Daudin has formed the genus *Tupinambis*, there can remain no doubt.

The polished section of a specimen from the Dorsetshire coast, which I obtained from Mr. Strange's Museum, displays the remains of an animal of this kind. In the remains of the head, teeth, vertebræ, &c. the characters of this animal may be detected.

LETTER XXII.

ORNITHOLITES.

The various coloured and figured stones, bearing accidentally the appearance of birds, need be here noticed only for the purpose of observing, that to such accidentally figured stones the ancients gave the names of *Hieracites* and *Perdicites*. Nor would it be necessary to mention here the pretended petrifactions of bird's-nests, eggs, &c. of Lesser, Gesner, Baccius, and others, but to remark, that there is every reason for believing that all these were either stones of the kind just mentioned, or mere incrustations, including the substances, which had themselves undergone no change. Specimens of this kind may be obtained at Matlock, in Derbyshire, and at various other places, where the water is surcharged with lime.

Few indeed of the supposed ornitholites of modern writers can support their claim to this distinction, when subjected to a careful examination. Thus the birds' beaks from Jena and Weimar, mentioned by Wallerius and Linnæus, are substances which, according to Walch, merely bear an external resemblance to these bodies.

But when it is recollected, that plants of the family of ferns, of *mimosa*, and of other terrestrial plants, are found in the same stones with the fossil fish at Vestena Nuova, Œningen, Pappenheim, and Rochesauve, no doubt can exist, that at the period when these fishes existed in the ocean, the whole surface of the globe could not be covered with water, but there were parts of the earth in which the riches of vegetation were displayed. *Ann. du Mus.* T. III. p. 19.

That a small part only of the surface of the earth was not then covered by water is also rendered highly probable, by the rareness with which the fossil remains of birds have been met with. So seldom, indeed, have such fossils been seen, that their existence has been doubted, I believe I may assert, by the greater number of oryctologists. Passing the erroneous accounts of the earlier writers on this subject, who appear to have considered different incrustations and figured stones as real fossil remains of birds, we have had the figure of a supposed ornitholite given in one of the numbers of the *Journal de Physique*, and the original specimen having been examined by M. P. Camper and the Abbé Fortis, neither of them would admit its supposed origin. An engraving was also given, in the same work, *Thermidor*, *An.* 8, of a stone, with the impression of the two legs of a bird; but it is said, that no one at Paris has seen the original specimen.

In the same work, however, an indubitable ornitholite, the foot of a bird, incrusted in the gypsum from the quarries of Clignancourt, near Montmartre, is figured and described by Cuvier, showing that real ornitholites exist in the ancient beds of gypsous matter. Blumenbach mentions the discovery of the bones of a water-fowl in the marly schist of Œningen, and the bone of one of the *anseres* in the calca-

reous schist of Pappenheim; *Manuel d' Hist. Nat.* T. II. p. 408. Faujas St. Fond has also presented us with two indubitable fossils of this class, being two feathers from the quarries of Vestena Nuova, imbedded in the same stone in which the fishes are found.

Fossil feathers are very rarely met with. A fine specimen of this kind is figured by Scheuchzer, part of a feather being enclosed in a piece of the fissile stone of Œningen. M. Walch also describes two specimens in his possession. One of these is the barrel part of the quill, about the size of a goose-quill, to which a part of the feather is adherent. The other is a small feather, with its tubular part.

A beak is described by Romé de Lisle, and figured in Davila's Catalogue, said to be from the neighbourhood of Reutlingen (Catalog. III. No. 25), which, in the opinion of M. Cuvier, is merely a bivalve shell, fixed obliquely in the stone. In the same work, a fossil bone of a bird is mentioned; but it is neither figured nor described; being only spoken of as being from Canstadt. This also, I conceive, should be admitted as an ornitholite, with much hesitation: bones which I have received from Canstadt, under the same description, are bones which are merely incrusted by a calcareous deposition. Scheuchzer speaks of the head of a bird in a piece of the black schist of Eisleben, but at the same time admits of its near resemblance to a pink-blossom.

The Abbé Fortis, than whom very few have had equal opportunities of exercising an excellent judgment on the nature and characters of different fossils, is remarkably sceptical as to any fossils of this description. This assiduous naturalist is not even satisfied with the specimens of fossil feathers of Mount Bolca, which have been just spoken of as having been figured by M. Faujas, *Annales du Mus. &c.* VI. p. 21, pl. 1.

Lamanon described, in 1782, the impression of a whole bird from Montmartre; but, in its delineation, he allowed his fancy rather too free scope, adding to it the feathers of the wings and tail. Fortis, on the other hand, examined the same specimen; and allowing his imagination to strengthen his prepossessions, at the same time taking

a few liberties with the original figure, determined it to be the remains either of a frog or toad. Cuvier has, however, since examined the same specimen, and is confident of its being really the remains of a bird. Subsequent examinations have discovered several bones of birds in the plaster quarries; and in a number, indeed, so great, as to leave no doubt of a considerable number of the fossil remains of birds being contained in these quarries.

To enable him to show satisfactorily to others the nature of the several specimens which he obtained, M. Cuvier has given the characteristic marks of the correspondent parts in the living animal; and the circumstances by which these parts, in birds, are distinguishable from those which approximate to them in form or appearance in other animals. Considering that information of this nature cannot but be highly acceptable to those who are engaged in pursuits of this kind, I have here introduced a sketch of the most important of these observations.

1st. The foot of a bird differs from that of any other animal, in having *a single bone in the place of the tarsal and metatarsal bones.*

2dly, Birds are the only class in which the toes all differ, as to the number of joints, and in which this number, and the order of the toes which have them, is nevertheless fixed. The great toe has two; the first toe, reckoning on the inside, three; the middle, five; and the outermost, five. The crocodile has the same number of phalanges as birds; but as these have each a metatarsal and tarsal bone, they cannot be mistaken.

There exist but two kinds of exceptions to this rule: the one is, that some birds have no great toes; but in these, the other toes preserve the usual order: the other is, in the ostrich and cassowars, which have three joints to each toe. The crocodile, indeed, has the same number of phalanges; but as every one of the toes is supported by a particular metatarsal bone, and these by several tarsal bones, the distinction is easily made.

The os femoris of birds is distinguishable from that of quadrupeds

by its external condyle, which instead of having in its back part a simple convexity for the outer pit of the head of the tibia, has two projecting lines: the one, which is the real condyle, and which answers to the upper and outer pit of the tibia, and to the inner pit of the fibula, is stronger marked than the other, which is more external, descends less, and rests on the upper edge of the fibula. Thus the external condyle, in birds, is forked, or hollowed out into a canal more or less deep, in its back part.

The only quadruped, in which any analogous structure is discoverable, is the kanguroo. In this animal there exists a slight depression on the back part of the external condyle of the os femoris; but the great width of the great trochanter, and several other characters, will always prevent the confounding of the os femoris of a bird with that of a kanguroo.

Reckoning upon the apparent specific characters of different thigh-bones, found in the neighbourhood of Paris, M. Cuvier concludes that they point out the remains of five or six different species of birds existing in these quarries.

The shoulder-bones of birds are also easily known, by the particular characters of their extremities. The head is always oblong, from right to left, playing in a corresponding groove formed by the scapula and clavicle; the two lateral ridges widening this part of the bone considerably. The lower end is distinguishable by an articular pulley, divided into two parts: one of which, the inner or lower, which is nearly round, is for articulation with the ulna; and the other, the outer or upper, which is oblong in the direction of the bone, and rises a little obliquely on the anterior face of the bone, is for the radius. In quadrupeds, the head is always round and the ridges small; and in the lower end, the ulnar pulley is always concave, and the radial is hollowed into a groove in those in which the fore-arm has no supination.

By nice investigation and comparison, M. Cuvier is supported in his conjectures, that he has found the mineralized remains of a pelican less

than *pelicanus onocratulus*, and larger than *P. carbo;* of one of the large curlews, with naked necks, disposed by Gmelin under the genus *Tantalus;* of a woodcock, a starling, and a sea-lark *(alouette de mer.)*

Judging from the form and proportions of a bone which I have in the marly schist of Œningen, eight inches in length, I suppose it to have been the tibia of some water-fowl. Its extremities are very much injured, and the bone has been split through its whole length with the stone; so that no characteristic marks can be observed.

On the back of the stone, and in different parts where it has been shivered, the seeming remains of feathers are observable. Another specimen, a slender bone seven inches in length, so deeply imbedded in the hard lime-stone of Stunsfield, in Oxfordshire, as not to allow either of its extremities to be examined, is, I have very little doubt, also either the tibia or tarsal bone of some bird.

LETTER XXIII.

FOSSIL REMAINS OF MAMMALIA.......CETACEA, WHALES, &C.......AMPHIBIA.....TRICHECUS, SEALS, &C.....SOLIPEDES, THE HORSE.

HAVING now to commence the examination of the fossil remains of those animals which are comprised in the Linnean class *Mammalia*, I feel that it may be necessary to endeavour to satisfy you with respect to the manner in which this part of my task is accomplished. I fear that you will, at first, experience feelings of disappointment, on my avowing to you, that the following pages will almost entirely be employed in placing before you the discoveries which have been made by

another; and you will probably imagine that this acknowledgment can hardly be made without occasioning me to experience some degree of mortification. But the truth is, that knowing, that as you proceed you must be highly pleased, I am thoroughly satisfied with merely recounting to you the most prominent particulars of those important discoveries, which have rewarded the patient and unabating exertions of Cuvier. If it should occur to you that the name of this justly celebrated anatomist should too frequently meet your eye in the following pages, remember that this necessarily results from the number and importance of his discoveries, and consider, that if we were giving a history of galvanism, of the alkalies, earths, metals, &c. how frequently in like manner, must the pen be engaged in reporting the important discoveries of our illustrious Davy. To have admitted less of the discoveries of Cuvier, in the present work, would have been unjust to those many who cannot obtain the voluminous, expensive, and almost prohibited works in which they are contained. To have introduced less would indeed have been to have sparingly employed the only light almost which has ever been thrown on this most interesting subject.

I must here also crave your attention, while I excuse myself for again departing from that classification which has been so long established by the truly great Linnæus. The natural method of classification, employed by Dumeril, *Zoologie Analytique, ou Methode Naturelle de Classification des Animaux, par A. M. C. Dumeril*, is generally adopted by Cuvier; and his discoveries are related in the nomenclature, as well as in the order of that arrangement. Hence, although it will not be difficult for those who wish to adhere to the Linnæan system to understand, with a little explanation, to what species, &c. every observation is intended to refer, yet it would be impossible, without considerable confusion, to give the discoveries of Cuvier in the terms, or agreeable to the arrangement, of that system; since his observations refer to particular families which are composed of genera, which in the Linnæan arrangement are dispersed under several different orders.

This may be instanced in the second family, whose remains we shall have occasion to inquire into; since, in speaking of the amphibia, the walrus, the seal, dugong, and lamantin, which constitute this family, are all referred to; whilst, in the Linnæan system, the trichecus, lamantin, and dugong, are found with the elephant, sloth, and other land animals, under the order *Bruta;* and the seals, with the dog, cat, &c. under the genus *Feræ**.

The remains of the family of *Cete* or *Ceti*, composed of *balæna, balenoptera, narwhalus, ananarchus, catodon, phylasus, physeterus, delphinus, delphinapterus*, and *hyperodon*, having *large spiracles in the top of the head, fins without nails, and no hind feet*, are, I believe, rarely found in a mineralized state.

Two specimens, fragments of the long projecting and spirally twisted tooth of the narwhal, improperly named *Monodon monoceros*, or *norwhalus*, was in the Museum of Sir Ashton Lever, one of which I now possess, and strongly suspect it to have been found on the Essex coast. Plate XX. Fig. 1, is a tooth, probably of some animal of this order. It is imbedded in a grey limestone, and is said to have been found in the neighbourhood of Bath.

Amphibia, comprising *pocha, trichecus, dugong*, and *lamantin, and having four paws in the form of fins, and frequently with unguiculated toes*, have left very few fossil remains.

M. Renou, professor of Natural History at Angers, found several bones of the lamantin *(Manatus)*, in that part of the department of Maine and Loire which is situated to the south of the Loire, and on

* Mr. Pennant observes: "To have preserved the chain of beings entire, Linnæus should have made the genus of *Phocæ*, or Seals, and that of the *Trichecus*, or *Manati* immediately precede the whale, those being the links that connect the *mammalia* with fish; for the seal is, in respect to its legs, the most imperfect of the former class; and in the *manati* the hind feet coalesce, assuming the form of a broad horizontal tail. *British Zoology*, Vol. III. p. 44. Cuvier considers the *lamantin*, the *dugong*, and a supposed *lamantin*, seen by Steller, in Beering, and possessing a hide like the hoof of a horse or an ox, as forming three distinct genera, composing a very different family from the seals, and which come as near to the *ceti*, as the *pachydermata* do to the carnivorous animals.

the two sides of the river Layon, in a calcareous bed formed of fossil fragments of shells. These bones were considerably mutilated, but were known to belong to phocæ, lamantins, and cetacea. *Ann. du Mus.* Tome XIII. p. 273.

Although these bones could be arranged under their proper genera, the species to which they belonged could not be ascertained. Thus a fossil skull, found with these bones, was determined to be that of a manatus, but of one different from those which are known. Three ribs, bearing the cylindrical form peculiar to the ribs of these animals, were found in the Commune of Capians, about ten leagues from Bourdeaux.

The bones which Esper found in the caverns of Franconia, and which he thought were the bones of seals, are undoubtedly the bones of terrestrial carnivorous animals. But some of the bones found by M. Renou, of Angers, were decidedly the bones of a seal, and twice and a half as large as those of the common seal, *P. vitulina*, which is now seen on the coast of France.

No decided remains of the Morse, or Walrus, *Trichecus rosmarus*, have been discovered in a mineralized state. Leibnitz imagined the elephantine remains of Siberia to have belonged to the Walrus; and Walch, Wallerius and Gmelin, have supposed the fossil jaw found in the neighbourhood of Bologna, *De Monum. diluv. in agro bonon. detecto*, to have belonged to the walrus; but Cuvier has plainly shown, that it is the remains of a small species of the mammoth *(Mastodon)*, as will be more particularly noticed in a succeeding letter.

I am unable to speak decidedly of a fossil tooth, said to be found in a bed of alluvial matters, in Norfolk. Its substance is very considerably changed: it is about fifteen inches in length, and appears to be nearly perfect at its extremities; although one side of it, and a considerable portion of its internal substance, is removed. The fineness of its grain and its edge not manifesting the peculiar lozenge-formed decussations observable in the ivory of the elephant and of the mammoth (*Mastodon*), with the size and form of the tooth, lead to the suspicion of its having belonged to an animal of this genus. On the other hand, neither its

form nor its size will prevent the supposition from being admitted, that it may be the tooth of some young animal of the genus ***Elephas.***

In the family ***Solipedes,*** one genus ***(Equus)*** only can be placed, having only ***one toe and one hoof***

The remains of the horse are only found in the looser alluvial depositions. I recollect no instance, in this island, in which its remains have been found imbedded in chemical depositions, which possess a stony hardness. Thus its remains are frequently found in peat-beds, in gravel, loam, &c. but not to my recollection, in limestone. From the strata in which they exist being frequently contiguous to the surface, these remains are often turned up with the plough; seldom exciting much notice, from their not being considered otherwise than as the remains of animals of but late existence. This notion has of course derived considerable support from the circumstance of these teeth, bones, &c. not differing from the living species of the present day.

Although so exactly agreeing with those of the present species, the teeth and bones of the horse are often found mingled with the bones of those animals which must have existed at a very distant æra, and even sometimes with the remains of those animals which are now unknown to us. Thus I have met with them, in this country, in the same stratum which has yielded the bones of the great Irish elk, of the elephant, rhinoceros, and hippopotamus, and perhaps of the mammoth. Cuvier himself saw hundreds of the teeth and bones of horses taken from the canal of Ourcq, mixed with those of elephants; some of the former being really petrified. At Canstadt, in Wirtemberg, they are found in prodigious numbers, with the bones of elephants, tigers, rhinoceroses, and hyeanas: they have also been found, thus associated, in Italy, in different parts of France; and in many of those beds, in other parts of the world, in which elephantine remains have been found. This, as is justly observed by M. Cuvier, is deservedly interesting; since, from the remains of the animals with which they are associated, it is probable that they lived before our continents existed in their present state.

The fossil remains of horses have been very seldom mentioned by authors. The fossil teeth of a horse are given by Bernia, in his edition of Aldrovandus on Monsters, as the teeth of giants; and Lang. ***Hist. Lap. Fig. Helv.*** Tab. xi. Fig. 1, 2, figures the tooth of a horse as the tooth of the hippopotamus. Kundmann has also engraved the teeth of a horse, without knowing to what animal they belonged; and Walch, having received some from Quedlimbourg, only observes, that they were similar to those which had been figured by Lang and Kundmann. Hence, Cuvier observes, that these having been so little noticed by former writers, is attributable partly to their not having excited their attention sufficiently, and partly to their ignorance respecting their origin.

A species of horse appears to have been the associate of elephants in former periods; but M. Cuvier is unable, from single bones and mutilated fragments, to determine in what points it nearest resembled the species of the present day.

As the fossil teeth of the horse are most likely to be confounded with those of the ox or buffalo, I shall place before you the following distinguishing characters.

The upper grinders of the horse agree with those of the ox and buffalo in their prismatic form, and are marked, like them, with four crescents; but they have also a fifth on their inner edge.

The lower grinders are more compressed, and have four crescents, the same as in the ox; but instead of being disposed two and two, parallel, they are placed alternately, the first of the inner edge corresponding with the interval on the outer edge.

The largest fossil tooth of this animal which I have obtained, is one which was found by Mr. D. Ward, at Great Wigston, near Leicester. The size of these teeth we, however, know may depend on circumstances not affected by the difference of species. Thus, if any of the teeth of one jaw are removed, the opposite teeth, in the other jaw, will grow to a very considerable length.

LETTER XXIV.

FOSSIL REMAINS OF RUMINANTIA.......FOSSIL ELK OF IRELAND........ STAGS, &C.......OX, BUFFALO, AUROCH, &C.

THE family of *Ruminantia*, or *Biscula*, of Dumeril, the order of *Pecora*, of Linnæus, are distinguished by *two toes and two hoofs;* the hoof being, as it were, cloven. The genera are: 1. *Camelus;* 2. *Moschus;* 3. *Cervus;* 4. *Camelo-pardalis;* 5. *Antilope;* 6. *Capra;* 7. *Ovis;* 8. *Bos.*

It is justly observed by Cuvier, that the study of the fossils of this family, either osteologically or geologically, is exceedingly difficult. The general resemblance to each other of the animals of this family is so great, that the several genera can only be characterised by parts, such as horns; which, from their frequently varying with age, sex, and climate, must, in their fossil and mutilated states, be very uncertain guides. The difficulties which occur, whilst considering them geologically, also applies to the fossil remains of the horse. The remains of the ruminants, except those of the Irish elk, and perhaps of some species of *Cervus*, do not appear to differ from the corresponding parts of the animals of our climates and our times; a circumstance in which they will be found to vary much from the remains of other families. The situations in which they are found appear also to be difficult to account for. Most frequently they are found in beds which appear to be of the more recent alluvial formation; but sometimes they are also found in those alluvial beds which, from their containing

the remains of the elephant, rhinoceros, hippopotamus, &c. in countries and climates where these animals have never been known to exist, were most probably formed before our continents existed in their present state.

Among the fossils of the British empire, none are more calculated to excite astonishment than the enormous stags' horns which have been dug up in different parts of Ireland. Dr. Molyneux, in 1697, published a paper on this subject in the Philosophical Transactions, Vol. xix. No. 227, in which he concludes that these remains are to be considered as a proof that the American moose-deer was formerly common in that island.

In this paper he particularly describes a pair of these horns which were found at Dardistown, near Drogheda. Mr. Henry Osborn, from whom Dr. Molyneux received them, says:—"This is the third head I have found by casual trenching in my orchard. They were all dug up within the compass of an acre of land, and lay about four or five feet under ground, in a sort of boggy soil. The first pitch was of earth, the next two or three of turf, and then followed a sort of white marle, in which they were found."

Plate XX. Fig. 2, is an outline sketch of these horns, drawn to the annexed scale. Their dimensions, Dr. Molyneux informs us, were as follow:

		Feet	Inches.
From the extreme tip of each horn	AB	10	10
From the tip of the right horn to its root	CD	5	2
From the tip of one of the inner branches to the tip of the opposite branch	EF	3	7½
The length of one of the palms, within the branches.	GH	2	6
The breadth of the same palm, within the branches.	IK	1	10½
The length of the right brow antler	DL	1	2
The beam of each horn, at some distance from the head	M		
In diameter		0	2 1/16
In circumference		0	8

		Feet	Inches
The beam of each horn, at its root, in circumference. .	D	0	11
The length of the head, from the back of the skull to the extremity of the upper jaw-bone.	NO	2	0
The breadth of the skull.	PQ	1	0

A similar pair, found ten feet under ground, in the County of Clare, was presented to Charles the Second, and placed in the horn-gallery, Hampton-court, but was afterwards removed into the guard-room of the same palace.

At Ballyward, near Ballyshannan; at Turvy, eight miles from Dublin; and at Portumery, near the River Shannon, in the county of Galway; similar horns have been found. In the common-hall of the Bishop of Armagh's house, in Dublin, was a forehead, with two amazing large beams of a pair of this kind of horns, which, from the magnitude of the beams, must have much exceeded in size those of which the dimensions are given above. Dr. Molyneux states, that in the last twenty years, thirty pair of these horns had been dug up by accident in this country: the observations, also, of several other persons, prove the great frequency with which these remains have been found in Ireland.

Various opinions have been entertained respecting this animal and its existing prototype, This, however, does not appear to have been yet discovered; and these remains may, I believe, be regarded as having belonged to an animal now extinct.

Dr. Molyneux, in the paper above referred to, in confirmation of his opinion that these are not the horns of the elk, observes, that the elk's horns "are much smaller, and quite of another shape and make; not palmated, or broad at the end furthest from the head, as ours; but, on the contrary, broader towards the head, and growing still narrower towards the tips' end;" and concludes with saying, "that it can only answer to that lofty-horned beast in the West Indies, called a moose.

Mr. Samuel Dale, in the thirty-ninth volume of the Philosophical Transactions, gives a description of the moose-deer of New England;

but observes, that the horn of the New England black moose best agrees with those found fossil in Ireland

Dr. Mortimer adds, in a note to this paper of Mr. Dale's: "As to the large horns found fossil in Ireland, I have taken particular notice (in several I have seen), besides the main horns being palmated, that the brow-antlers are likewise palmated; which is a circumstance peculiar to the rein-deer species, being of great service to them in removing the snow, in order to get at the grass or moss underneath, which is their chief subsistence in Lapland."

M. Cuvier observes:—"Il est cependant certain que les bois fossiles d'Irlande ne peuvent venir ni de l'elan ni du renne: nous n'avons pas besoin de la prouver au long pour ce dernier, puisque leur difference saute aux yeux; l'andouiller qui descend sur le front, et qui a seul donné lieu à la comparaison, étant toujours simple dans le fossile, et jamais branchu comme dans le renne." The fact however is, as M. Cuvier has stated it, that the brow-antler in the rein-deer is palmated, and that in the fossil animal it is generally not: it is however sometimes flattened.

It now remains to examine into the degree of accordance between these fossil horns and those of the elk, with the horns of which animal these horns have been most frequently supposed to agree. The first comparative view furnishes us with these facts, that the fossil horns far surpass in size the horns of any known elk; and that, in the horns of the elk, the antlers are much more numerous than in the fossil horns; so that the fossil horns, although by far the largest, have the fewest antlers. In addition to these, M. Cuvier notices the three following essential differences: 1. The antler, which in the fossil horn descends from the bottom of the beam, over the forehead of the animal, does not exist in the elk. 2. The fossil horn has antlers passing out from the inner edge of the palm, which is not the case with the horn of the elk. 3. The palm of the fossil horn enlarges by degrees, and takes the form of a fan; whilst that of the elk is widest at its lower part, and narrows as it ascends. Another very important difference results from the large cartilaginous

and fleshy muzzle of the elk. The space required by this part reduces the bony parts, and extraordinarily enlarges and elongates the bony openings of the nostrils, and necessarily shortens the proper bones of the nose; but nothing of this kind is discoverable in the fossil skull. The fossil head differs also from that of the elk in the proportion between the length and the width: in the former the width bearing a proportion to the length, as one to two; and, in the latter, as one to three.

It appears, that the magnitude of the fossil head does not by any means keep pace with the enormous size of the horns; the largest fossil head not exceeding two feet, which is shorter than that of the common elk. To calculate the size of the body from that of the head, seems hardly admissible; and not having yet obtained any authentic account of the discovery of any of the bones of the trunk, or of the limbs of this animal, there exists no sufficient basis for conjecture on this point.

The resemblance which has been supposed to exist between this fossil and the moose-deer, or elk of America, M. Cuvier contends is imaginary; observing, that there does not appear to be any real specific difference between the European and the American elk. Every thing, therefore, he observes, agrees in authorizing us to consider the fossil elk of Ireland as an animal belonging to a species, which, as will be shown to be the case with several others, is now become extinct.

The frequency with which these remains are found in Ireland is a circumstance not very easily explained, when it is also considered that the discovery of any of these remains in any other part of the globe is a very rare occurrence. A fragment of a horn, apparently of this species, has been found on the Rhine, near to Worms: *Ecrits de la Société des Naturalistes de Berlin*, p. 388. In this specimen, the brow-antler is flattened. The upper part of a skull, with two beams, resembling in their form and proportions those of the Irish elk, have been found in the canal of Ourcq, near to Sevrau, in the forest of Bondi, in the neighbourhood of that spot where we have already seen the remains of elephants were discovered.

The only instance which I find mentioned of these remains being found in England, is related by Mr. Thomas Knowles, who states that a pair of horns was found six feet under ground, in a peat-moss, near North Dreighton, in Yorkshire, in the year 1744. These horns Mr. Knowles describes as being each of them five feet and an inch in length, and palmed; and observes, that they were not at their full growth, since they were yet covered with what is called *the velvet*. *Phil. Trans.* Vol. XLIV. Dr. Mortimer observes, in a note to this paper, that the horns mentioned by Mr. Knowles are evidently of the same sort as those which are so often found in Ireland: but adds, "I do not remember to have met with any before of this species found in England, or any where else besides Ireland."

Previous to my having visited the neighbourhood of Harwich, John Hanson, Esq. of Great Bromley Hall, Colchester, very kindly favoured me with a view of the fossils which he had obtained from the Essex coast, as well as several correct drawings from them, and two or three of the specimens themselves. Among those in Mr. Hanson's possession was the beam of a horn, so large, and at the same time possessing a form so much resembling that of the Irish fossil horns, as led me, at the time, to mention their agreement.

At my first or second visit to Walton, I procured the corresponding beam with that possessed by Mr. Hanson, and with it a fragment of the palmated part; and, in 1808, I obtained from the same place the forehead, with the beams of both horns, broken off just at the commencement of the palmated part. This specimen very much resembles, except in being larger, one which was found in the canal of Ourcq, and which is figured by Cuvier in Pl. I. Fig. 9, of *Ruminans Fossiles*. The agreement is very close between the proportions of the Essex specimen, and those which are given by Dr. Molyneux of the Irish horns, allowing for a circumstance which I did not expect, that the Essex horns exceed the other in size. The breadth of the skull of the Irish fossil, in its broad part, is 12 inches; and of the Essex skull, of which only

the narrowest of its upper part is left, is nine inches. The circumference of the beam of the horn, at its root, is in the Irish 11 inches, and in the Essex fossil 12 inches. The circumference of the beam, just before giving off the palm, is in the Irish fossil eight inches, and in the Essex ten inches.

In Scania (*Mem. de l'Acad. de Stockholm, de* 1802, p. 285), in France, in the valley of Somme, near Abbeville; and in Germany, fossil horns have also been found, which resemble in figure those of the Fallow-deer, but are one-third larger; and which, in the opinion of Cuvier, belonged to some unknown animal.

Horns, resembling those of the common stags are very frequent in beds of alluvial production. In France, in the valley of Somme, these horns are found in very considerable numbers, either in the turf or sand. They are also found in several other parts of the continent.

These fossils have been also frequently found in different parts of England. Lancashire, Yorkshire, Derbyshire, Northamptonshire, Oxfordshire, and Lincolnshire, are all mentioned in the Philosophical Transactions as having yielded these fossils: but Norwich, perhaps, has furnished more of these specimens than any other spot in this island. This species of horns also constitutes a part of the fossil treasures of the neighbourhood of Harwich; affording another instance, with that yielded by the valley of Somme, of these remains being associated with those of the elephant. Here, indeed, they are found, not only with the remains of the elephant, but also with those of the ox, of the fossil elk, the rhinoceros, and the hippopotamus. A large horn of this description is figured in the 37th volume of the Philosophical Transactions, No. 422, which was drawn up by the net of a fisherman, out of Raven's-barrow-hole, adjoining to Holker Old Park, on the sea-coast of Lancashire.

M. Guettard discovered, between the blocks of sand-stone, and in the surrounding sand, in the neighbourhood of Etampes, with other bones of different sizes, the bones of an animal, which appears to have been of a size between that of the stag and of the roebuck. When these horns were first shown to the Academy of Sciences, they were suspected to

have belonged to some young animals of the species of the rein-deer, before they had acquired their characteristic palm.

These horns are distinguishable by their being very small, thin, and rather flat; and by their giving off, at a little distance from their base, one or two antlers on their fore part. From a variation in this last circumstance, depending very probably on a difference in the age of the animal, these horns may be divided into two sorts.

In the one, at about two inches above the coronet, an isolated antler is given off forwards; and then the beam itself, which is but little larger than this antler, turns backwards, to be again divided, or at least to give off a second antler on its posterior part. A specimen of this sort, from Etampes, which I purchased from the collection of Mr. Strange, and which bears the description of "*A fossil horn of an animal unknown to Dr. Hunter*," is represented Plate XX. Fig. 3; the dotted lines, in continuation, showing the manner in which the second antler was given off. In the other sort, two antlers are given off forwards, at about an inch from the base, and at a little distance from each other, the beam then passing backwards. It is worthy of notice, that although the root is nearly round, the beam immediately becomes flat; and this is particularly the case in the horns of the latter sort.

That these are not the horns of young rein-deer is evident; not merely from their not agreeing in all the characters of these horns, but from their having belonged to adult animals, whose epiphysis were in union with their bones. There is no animal of the old continent to which these bones can be referred, nor do we know that the analogue of this fossil animal is to be found on the new continent.

In the quarries of Montabusard, in which it will be seen that two species of the genus *Palæotherium* and one of the genus *Mastodon* have been discovered, two fragments of the horns, and several portions of the jaws, which are not distinguishable from those of the common roebuck, have been found. This is a circumstance truly interesting,

since we have here, on the same spot, the bones of lost animals, as well as of animals similar with those which are now in existence, in the same country in which these fossils are found.

M. Faujas, on comparing the different large fossil heads of the ox kind, in the Museum of Natural History, was surprised to find that they differed, not only in their size and form, but in other characters also, from the urus, or aurochs, of Lithuania. By the examinations which he made, he also became convinced that these fossil horns were of two distinct species.

The core or bones of the horns of the first species are placed in a horizontal position, and at rather more than fifteen inches from their base are fractured; but the size and form of the remaining part show, that, if there had been any curve, it must have been at the extremity. Although the animal must have been young, the bones of the horns, at their base, were more than twelve inches and a half in circumference; and the distance from one orbit to the other, more than thirteen inches. The distance from the upper extremity of the forehead to the edge of the occipital foramen is little more than four inches and a half; and on the forehead, between the commencement of the two horns, is a slight protuberance of an oval form. These two last circumstances M. Faujas considers as particularly distinguishing this from the other species.

In the second species the forehead, which is quite flat, is to be considered, at its upper extremity, rather as forming a line, with a little convexity, towards its centre, than as having a protuberance. The horns form a kind of crescent, the inclination of which is downwards. The distance of one horn from the other, taken at their extremities, is two feet six inches and a half; the circumference of the core of the horn, at its base, thirteen inches; and from the upper edge of the forehead to the edge of the occipital foramen, but four inches.

These horns he considers as having been brought from India by the same revolution which has removed those remains of elephants

and rhinoceroses which are dug up in the North of Europe, in France, Italy, and England.

On these opinions of M. Faujas, M. Cuvier observes, that it is not necessary to go so far as the Indies to find the living species to which these horns belong. The truth is, he says, that the first of these skulls is that of an auroch, with no difference which can reasonably be considered as specific; and the second belongs, he conceives, simply to the species of our domestic ox, of which it has all the characters. The magnitude of them, compared with the common skeletons, and the direction of the horns, occasion the illusion; but these, he adds, are circumstances which naturalists know are not constant characters, and not proper to be employed for the distinction of species.

To assist you in making the necessary distinctions, I shall here introduce to you the osteologic characters of the skulls of the aurochs and the ox, as given by M. Cuvier himself*. "The forehead of the *ox* is flat, and even a little concave; that of the *auroch*, although a little less so than in the *ox*, is rather tumid. In the *ox*, the forehead has a square form, being nearly as high as it is wide, taking its base between the orbits; in the *auroch*, measuring it in the same way, it is much wider than it is high, the width being to the height as three to two. The horns, in the *ox*, are attached to the extremities of the projecting line at the top of the head, which separates the occiput from the forehead; in the *auroch*, this line is two inches backwarder than the roots of the horns. In the *ox*, the plane of the occiput makes an acute angle with the forehead; in the *auroch*, this angle is obtuse. Lastly, the plane of the occiput, which is quadrangular in the *ox*, forms a semicircle in the *auroch*." The characters which M. Cuvier here assigns to the ox are common to all its known varieties.

To these distinctive characters, taken from the skull, may be added these, which serve to determine the propriety of regarding the auroch

* Ménagerie du Mus. d'Hist. Nat. art. du Zebu.

as a different species from the ox. M. Daubenton ascertained, that in the auroch there are fourteen pair of ribs; whilst in the ox, and the greater part of the other ruminants, there are only thirteen: in the auroch, the legs are longer and thinner than in the bull or buffalo; its tongue, also, M. Gilibert observes, is of a blue colour.

Those naturalists appear to have been mistaken who have supposed that there exist, in the North of Europe, two species, different from each other: one without a bunch, which they term the *auroch;* and the other with, which is considered as the *bison.* The difference appears to be, that which results from the difference of age only; the old male auroch acquiring much longer hairs, and a much larger projection, than exists in the female or the young. The identity of the auroch with the large wild bull or buffalo of America (*Bos Americanus*, Linn.) is not yet determined; an examination of the osteological characters of its skull is therefore desirable.

Justice to M. Faujas requires the observation, that M. Cuvier has by no means established the fact, that the fossil horns of the first species are those of the aurochs; since he has by no means pointed out any osteological character which can be considered as deciding the question.

It is very true, that the difference of size alone is not sufficient to determine a difference of species. But when the difference of size is enormous, the probability of there existing a difference of species is rendered more probable. The prodigious size of these fossil horns is attempted to be accounted for by M. Cuvier, on the consideration, that the horns grow through the whole life of the animal, and that an abundance of nourishment, through a long life, might have had a considerable effect in increasing the growth of these horns. But a long life does not appear to have been necessary for the production of the large horns of this animal; since M. Cuvier himself observes, of the specimen figured by M. Faujas, that "the skull is of an enormous size, although the individual to which it belonged was not very old, as appeared by the sutures." Nor can the magnitude of the horns

be attributed to abundance of nourishment; since, as M. Cuvier observes, in the paragraph just quoted, the skull itself is of an enormous size; and it cannot be unfair to infer, that the other bones of the animal were in the same proportion: and that such a prodigious size of the bones of the whole animal can be attributable merely to plenty of nourishment, I cannot suppose to be admissible.

The bone of a horn, most probably of this species, found by Mr. Peale, in Kentucky, was of still larger dimensions than those in the Museum of Natural History, since the circumference of its base was more than eighteen inches. Another fossil core of a horn, probably of this species, is described by M. Mayer, which must have even exceeded this in magnitude.

The second species of these horns surpass in size those of our domesticated oxen, and differ from them also in having a different direction. The skulls to which these horns are attached are very different from those of the aurochs; and, as has been already remarked, are supposed by M. Cuvier to have belonged to a very different race; to that wild race, which was the original stock of our present domesticated oxen. The osteological characters of the skull, he supposes, prove their affinity; and the difference in the direction of the horns, he conceives by no means a character sufficient to mark a species.

Horns of this latter description have been frequently found. Several have been found in France; and M. Faujas has seen them in the cabinets of Manheim and of Darmstadt, and in that of M. Saltzwedel, at Francfort. They have also been dug up in the neighbourhood of Stuttgardt; and M. Soldani describes a skull of this species, found near to Arezzo, the forehead of which was a foot wide, and the horns two feet seven inches long, and fourteen inches in circumference at their base. He also mentions another found near Rome, at the depth of twenty feet. The width between the orbits was fourteen inches; and the circumference of their core, at its base, was eighteen inches. *Essai Oryctographique*, Pl. XXIV. and XXV. Gesner, more than two

hundred years ago, engraved a skull of this sort, the design of which was sent him by his friend Caius, who informs us he had seen a similar skull in Warwick Castle. The specimen of this fossil which I possess was dug up in Dumfrieshire. The following are its measurements:

	Feet.	Inches.
The length of the bony core of each horn	2	6
Circumference at its base	1	5
Width of the forehead at the root of the horns ...	1	$0\frac{1}{2}$
Distance of the tips of the horns from each other	2	11

M. Pallas describes a fossil skull found in Siberia, which he concluded to have belonged to the common buffalo of India and of Italy; to which opinion he was led by the angle or ridge, which runs the length of the horn. *Nov. Com. Petrop.* XIII. p. 460.

The examination of this fossil induced M. Cuvier to conclude, that this could not be a skull of the common buffalo; since, in this animal, the width of the head is less in proportion to the length than in the fossil, particularly between the orbits; the distance of which, in the fossil, is a striking character. The curvature of the horns is also different. In the common buffalo they turn backwards, at the side, and upwards, without coming forward; but, in the fossil, they go obliquely upwards by the side, and their point comes forward. The longitudinal projecting angle also appears to be less strongly marked.

M. Pallas, indeed, afterwards concluded, that these horns were not of the common buffalo, but of a supposed large species described by Dr. Anderson in the *Bee*, Dec. 1792, and to which the name of *Arnis* has been given. But M. Cuvier offers very good reasons for supposing that mistakes have been made with respect to the size of this animal, which he conceives to be nothing more than a race of buffaloes, with uncommonly large horns, but by no means of a particular species. From every consideration, he is therefore led to suppose that the fossil buffaloes' heads of Siberia belong to a particular species,

entirely different from the common buffalo and the *arné*, as well as from the ox and the aurochs.

These skulls have been found on the banks of the rivers in the furthest parts of Siberia; but sufficient is not yet known of the situation in which they are found, to allow of the ascertaining of the nature and comparative age of the beds in which they are found. Arguing upon what is known respecting these fossils, M. Cuvier concludes, that they are cotemporary with the elephant with long alveoli, and with the rhinoceros with a long skull. This he, however, admits cannot be received as certain, until we obtain more exact accounts respecting the places in which they were found.

To M. Pallas we are likewise indebted for the knowledge of another species of fossil skulls found in Siberia. Of these he found only two: one on the borders of the Ob, and the other on the side of Tuadra. *Nov. Com. Petrop.* XIII. p. 601. These skulls are chiefly characterized by the near approximation of the bases of the horns. M. Pallas, at first, suspected that these skulls were similar to those of the buffalo of the Cape; but soon after found reason to attribute them rather to the musk-ox *(Bos moschatus)* of Canada. M. Cuvier is fully disposed to concur with M. Pallas in his last opinion.

Admitting the identity of these skulls with those of the musked ox of America, Cuvier observes, that it should be remarked that they are in a relative position very different from that of the other fossil bones of that country. The only analogues with these latter, which it is supposed that we have found, are in the torrid zone, &c.: but the musk ox dwells in the frigid zone. It is therefore, he thinks, probable, that if these skulls actually belong to this animal, they will be found to have been deposited in depths, and in beds, very different from those which have furnished the bones of elephants, rhinoceroses, and large buffaloes.

Reviewing these facts, relative to the remains of ruminants found in alluvial tracts, M. Cuvier offers the following remarks.

These remains, as well of the stags as of the oxen, appear to be referable to two classes, the unknown and the known ruminants. In the first class he places the Irish elk; the small stag, with slender horns, of Etampes; the stag of Scania; and the large buffalo of Siberia: in the second class he places the common stag, the common roebuck, the aurochs, the ox which seems to have been the wild original of our domestic ox, and the buffalo with approximated horns, which is analogous with the musk-ox of Canada. Besides these, there appears a dubious species, the great deer of La Somme, which much resembles the common fallow-deer.

From what can be determined, with respect to the beds in which they are found, the known species are always, he observes, in those which are more recent than those in which the unknown species are found. This, he says, is certain, at least as to the stags, the roebucks, and the oxen, of the valley of La Somme, which are in the loose and superficial sands, or in the turf. The aurochs equally appear to be found in the alluvial tracts of recent formation, which are yet susceptible of augmentation or diminution; and the stags' horns of England have been frequently taken out of rivers.

As to the unknown species, it must be remarked, he says, that the elk of Ireland, although it is necessary to get through the beds of turf to find it, yet it is not in the turf itself, but in the beds beneath it: the stag of Etampes, found in the sand of La Beauce, was lower than the earth deposited from the fresh water, which covers the sand; and lastly, the buffalo of Siberia, accompanying the fossil elephants and rhinoceroses, may be supposed to be of the same period, and to be enveloped in the same beds. The stag of Scania is the only one of the unknown animals which has been said to be found in the turf; but this circumstance, he thinks, requires to be proved.

The knowledge which we at present possess of the situations in which fossils are found is at present so confined, as to give but little solidity to the opinions which he here offers. A remark of another

kind is made with a much greater assurance of its certainty. The known fossil ruminants are also animals of the climate in which they are now found; thus the stag, ox, aurochs, roebuck, musk-ox of Canada, now dwell, and have always dwelt, in the cold countries; whilst the species which we consider as unknown, if we must refer them, at all events, to existing analogues, must be sought for in the warm countries. Our unknown fossil ruminants, in part, follow this analogy. The great buffalo of Siberia can only be compared with the buffalo of the Indies, or *arnis:* in the same manner, it is pretended, that in the elephant of India, and in the rhinoceros of Africa, are to be found the originals of the fossil elephant and rhinoceros, with which are found the bones of this buffalo. The elk of Ireland, and the stag of Etampes and of Scania, may indeed be compared with the animals of the cold countries; but they do not approach so near to them, he thinks, as to invalidate his reasoning.

The facts, then, which are hitherto collected, seem, he thinks, to announce, at least as plainly as imperfect documents can, that the two sorts of fossil ruminants belong to two orders of alluvial deposits, and consequently to two different geological epochs; that the one have been, and are now daily being buried, in the period in which we live; whilst the others have been the victims of the same revolution which destroyed the other fossils of the loose beds, such as the mammoths, the mastodons, and all the pachydermata, the genera of which now exist only in the torrid zone.

LETTER XXV.

FOSSIL BONES OF RUMINANTS, &c. IN THE ISLANDS OF CHERSO AND OSERO.......ISLAND OF CERIGO.......AT NICE AND ANTIBES.......AT CETTE.........NEAR CONCUD, IN ARRAGON.......IN THE ROCK OF GIBRALTAR.

Few among the interesting objects which present themselves for our examination can appear more wonderful than those which are now to engage our attention. In the rock of Gibraltar, in Arragon, in Nice, and Antibes; on the more northern shores of the Mediterranean; in the more northern parts of the island of Corsica; in Dalmatia, and in the islands of Cherso and Osero, as well as in several others of the islets of the Adriatic, the bones of similar animals have been found deposited, in situations and under circumstances extremely similar. Or, in the expressive language of Cuvier: "Des rochers epars, et souvent isoles a plusieurs centaines de lieues les uns des autres, mais formes de la meme pierre, sont fendus en differens sens; elurs fissures sont remplies d'une concretion semblable partout, qui enveloppe des os et des fragmens de pierres, et a toutes ces distances les fragmens de pierres, et les os sont a peu pres les memes. *An du Mus.* Tome XIII. p. 169.

The first notice which appears to have been given of these fossils was in 1745, by Vitaliano Donati, to whose assiduous inquiries I have already acknowledged my obligations, whilst examining into the structure of the recent alcyonia. In the work there referred to, *An Essay*

on the Natural History of the Adriatic Sea, p. 8, French translation, being the only copy of the work which I possess, he says: "Dans le voisinage des Iles appelles, Incoronate, est un rocher nomme Jadra, qui est tout plein de Debris de petoncles entierement changes en substance de marbre.

"Peu loin de ce rocher on trouve un bas fond, ou banc, appelle Raspp, ou l'on voit des os d'homme petrifies. Ils sont dans un melange de marbre de Rovigno, de terre rouge, et de stalactites. C'est pourquoi je ne crois pas cette petrifaction aussi ancienne que les autres. J'ai aussi deterre de ces os petrifies avec le meme melange a Rocosniza pres de Sebenico, et sur les bords de la riviere Cicola du cote de Dernes."

Abbé Fortis added to his other Philosophical labours that of repairing to the islands of Cherso and Osero, to observe these wonders. The frequent heaps that are seen, the sameness of the substance, the variety of the positions, and the similar materials of the congeries, might give room to conjecture, he says, at first sight, that one immense stratum had been thus composed in remote ages.

There are two different heaps on the desert rock of Gutim; and a mile from Gutim, at a place called Platt, on the island of Cherso, other heaps are to be seen, He also found them in the caverns of Ghermoshall, and at Porto Cicale, in the post of Vallishall, and at Balvanida. Two large heaps were also found in the small island called Canidole Picciola, and others in the small island of Sansego. The same characters, he observes, marks the Illyrick bones over all these islands and along the coasts of Dalmatia. Along the torrent Cicola, between Sibenico and Knin; in Isola Grossa; in Corfu, in the Ionian sea; and in the isle of Cyprus—it appears, that similar fossil bones exist. Among these bones the Abbé Fortis discovered the bones of sheep, and the teeth of horses and oxen; with other bones, which he believed to be human. *Travels into Dalmatia by Abbé Alberto Fortis*, p. 440, *et seq.*

The island of Cerigo, in the Archipelago, is also mentioned by the Abbé Fortis, as possessing these fossils; which circumstance is also

mentioned by Spallanzani; who, without sufficient authority, also conceived these bones to be human.

The accumulation of these fossils at Nice and at Antibes, have been particularly noticed by M. Faujas. *Ann. du Mus.* Tom. x. p. 409, &c. The rock which bears the castle of Nice, and in which these remains are found, is in a manner the last extremity of the chain of Alps, which bifurcates a little, to form towards the West the mountains of Provence, and towards the East those of Gènes, which are themselves the beginning of the chain of the Appennines. These fossils, according to Faujas, are also found in the ruins of Cimiez, an ancient city, a little higher up than Nice; and there is also reason to conclude, from his description, that the mountain of Montalban, Villefranche, and the greater part of those which surround the plain of Nice, are covered with a reddish ochry earth, similar to that which abounds in the Breccia, which contains the bones. The city of Antibes is separated from that of Nice only by a bay about four leagues wide, which appears to be surrounded by hills of the same nature.

At Cette also, at the beginning of the canal of Languedoc, between Montpellier and Agdé, on the Mediterranean, these fossils are also found. The mountain of Cette is an isolated cone, which is connected with the land by a very narrow neck of sand. Very lately M. Rampasse has discovered similar fossil remains in Corsica. These are at some distance to the north of Bastia, at about half a league from the sea, and at about a hundred fathoms above its level.

Cueva-rubia, a hill near to Concud, in Arragon, appears also to contain fossil bones; but the cementing matter differs from that of the preceding fossils both in its grain and colour. Fossil bones are also found at Romagnano, in the valley of Pantena and of Ronca; but these, like those of Concud, seem to differ from those previously mentioned, in the nature of the connecting matter. Mr. Bowles believed that he had found here the bones of the legs and thighs of men and women; but Cuvier observes, it must require great practice in

researches of this kind, to make such a distinction, in fossil bones, almost always mutilated.

We are indebted to Major Imrie for a most useful and interesting mineralogical description of the mountain of Gibraltar, in the fourth volume of the Transactions of the Royal Society of Edinburgh, p. 191, the whole of which is highly worthy your examination. That which most particularly demands your attention I have here introduced.

The eastern side of the mountain, mostly consisting of a range of precipice, terminates with a bank of sand in the Mediterranean. The southern extremity terminates in the sea, with a rapid slope, and forms Europa Point. On the Western side, this peninsula mountain is bounded by the Bay of Gibraltar; and upon the North, it is attached to Spain by a low sandy isthmus, the greatest elevation of which, above the level of the sea, does not exceed ten feet; and its breadth, at the base of the rock, is not more than three quarters of a mile. This isthmus separates the Mediterranean on the East, from the Bay of Gibraltar on the West.

The principal part of the rock consists of a grey dense marble, in some parts of which are imbedded testaceous bodies, in a spathose state. As is almost always the case, where this species of rock constitutes large districts, the rock of Gibraltar is cavernous; the caverns being beset with stalactitic, and other calcareous infiltrations. On the surface of the rock are seen pot-like holes, hollowed out by the attrition of gravel or pebbles, set in motion by the rapidity of rivers, or currents in the sea, some of the pebbles now remaining in them. From this phænomenon, Mr. Imrie concludes, that however high the surface of this rock may now be elevated above the level of the sea, it has once been the bed of agitated waters.

With respect to the fossil bones found in this rock, the general idea concerning them is, that they are found in a petrified state, and inclosed in the solid calcareous rock; but these are mistakes which Mr. Imrie thus aims at correcting:—" In the perpendicular fissures of the rock,

and in some of the caverns of the mountain (all of which afford evident proofs of their former communication with the surface), a calcareous concretion is found, of a reddish brown colour, with an earthy fracture and considerable induration, including the bones of various animals, some of which have the appearance of being human. These bones are of various sizes, and lie in all directions, intermixed with shells of snails, fragments of the calcareous rock, and particles of spar; all of which materials are still to be seen in their natural uncombined states, partially scattered over the surface of the mountain. These having been swept by heavy rains, at different periods, from the surface into the situations above described, and having remained for a long series of years in those places of rest, exposed to the penetrating action of water, have become enveloped in, and cemented by, the calcareous matter which it deposits." It is right here to observe, that Mr. Boddington ascertained that these bones had been found fifty-seven feet above high-water mark. *Phil. Trans.* Vol. LX. p. 414.

This concreting matter may, in some places, be traced from the lowest part of a deep perpendicular fissure up to the surface of the mountain. In many parts of the rock this concretion exists, unmixed with bones of any kind: and on the elevated parts of the mountain, masses are found, consisting of snail-shells combined with a mass of opaque stalactitical spar of a yellowish brown colour. This spar often incrusts the inner surface of the hollow bones: sometimes the spathose crust is colourless, and sometimes of a reddish colour. The concretion in which these bones have been found, in Dalmatia, at Cette, Nice, Antibes, and Cerigo, agrees very closely, in its situation, colour, and composition, with that of the rock of Gibraltar.

The fossil remains of animals, we have seen, are found in the Vicentin and Veronese, but it does not appear to be certain that the concretions containing these bones, any more than those of Concud, are of the same kind with those of Gibraltar, Dalmatia, &c.; their connecting matter being of a different grain, and of another colour:

nor has it been ascertained that they are found in similar situations.

Many of the bones which have been thus found, have been supposed to be of human origin. Such was the opinion, at one time, of the Abbé Fortis and of Dr. Hunter; but further observation has shown, that this was erroneous. The latter gentleman, on the inspection of more distinct specimens, corrected his former report on this subject, and determined them to be the bones of quadrupeds. Further examination afterwards enabled Mr. John Hunter to ascertain that these bones belonged to the family of Ruminants, to the genus *Lepus*, and to the class of birds. Some, he also observed, belonged to a small dog or fox. *Phil. Trans.* 1794, p. 412.

Major Imrie also remarked, that some of these bones are apparently human, and that these are chiefly vertebræ and bones of the upper and lower extremities. These are scattered among others, of various kinds and sizes, even down to the smallest bones of small birds. He found a complete jaw-bone of a sheep, with its full complement of teeth, the enamel of which was perfect. Two skulls were found, which were supposed to be human; but these appeared to Mr. Imrie to be too small for the human species, and seemed rather to belong to a species of monkey, of which considerable numbers still inhabit the inaccessible parts of the rock.

To the indefatigable and justly celebrated Cuvier, we are indebted for still more correct information respecting these remains. The greater number of these bones, he observes, were evidently broken before they became incrusted; but do not appear to have been bowldered. They are disposed in every direction, in the red stone which encloses them; and by their not touching each other, we have proof that the concreting matter formed on them as the bones gradually fell in. This matter, he observes, resembles well-burnt brick earth, and has many small cavities, some of which are partly, and others quite filled, with a spathose matter, similar to that found in the cavities of

the bones. The bones, he says, are decomposed, and very white: they, however, are not wanting in hardness, and may be even considered as petrified. The enamel of the teeth is unaltered. The impressions of shells are those of land-snails: there are no traces of sea-shells.

M. Cuvier is satisfied, that among the considerable number which he possesses of these fossil bones, there are none but the bones of a ruminant, hardly of the size of a deer. These, from there not having been any horns or branches found, and from the lower head of an os femoris, which he possesses, resembling that of the antelope more than that of the stag or sheep, he is disposed to refer to the antelope. In the propriety of this, he is confirmed by the appearance of the teeth, and of the other bones which he possesses.

It does not appear that any remains of any of the class of *rosores (rongeurs*, mammifères onguicules sans dents canines ou laniaires) have been found in this rock, except by M. Adrian Camper, who has two halves of a jaw, and some other bones, which appear to be referable to the genus *Lepus*, but which are too small for the common rabbit. Having ascertained that the remains of a species of *Lagomys* exist in the breccia of Corsica, and that the jaw-bones were about the same size with the one found at Gibraltar, he proposes, as an interesting object of research, the ascertaining whether traces of any animal of this species are discoverable in the docciæ of the rock of Gibraltar.

In the breccia of Cette, M. Cuvier discovered the bones of five different species of animals; those of the common wild rabbit, and which were most numerous; of a rabbit one third smaller than the preceding; of an animal resembling the field-mouse *(mus arvalis)*; of a bird of the size of the common wag-tail; and of the common adder. It is, however, by no means certain that the fossil rabbits were in their exterior similar to ours; since those differences, which mark the rabbit of Egypt and of North America as distinct species, are not discoverable in their osteology.

Learning that M. Gouan possessed an os femoris from Cette, which

had been said to be human. M. Cuvier examined it, and found that it had belonged to some ruminant about the size of a deer, and perhaps to the same animal with that whose remains are found at Gibraltar.

The shells found here were of three sorts, two helices and a pupa; but no trace whatever of any sea-shell or of any marine animal, contrary to the opinion of M. Faujas. *Annales du Mus.* Tom. x. p. 410.

The bones contained in the ossiferous brecciæ of Nice and Antibes are, according to M. Provencal, physician of Montpellier, only those of herbivorous animals; and, according to M. Cuvier, of horses and of ruminating animals. Of the latter, he has seen the remains of two species: the bones, or rather the teeth of one of these, appear to be of the size of those of the calf, and the others of those of the stag. No teeth of any smaller animals have been found here.

The shells are all terrestrial, being helicæ or pupæ. The *Helix algira* was found adhering to a jaw like that of a stag, by M. Provencal, but no remains of marine animals have been found. M. Faujas, indeed, speaks of serpulæ, and a volute, which was said to have been found here; but these were shown him in a cabinet, and of course he might have been deceived.

The ossiferous brecciæ of Corsica differ materially from those of Gibraltar, since they do not yield any bones resembling those of sheep or deer, but only those of the size of the rabbit, guinea-pig, or rat.

All the fossil bones of Corsica, which have been examined by M. Cuvier, are of the class of *rosores;* but they do not, like those of Cette, belong to species common to the adjoining country, since he found a complete head of a genus, the species of which have been but just discovered in Siberia.

By the flatness of the skull, the upward direction of the orbits, the hooked apophysis at the base of the zygomatic arch, and by the long apophysis which carries this arch backwards, he was led to compare it with the skulls of the little hares without tails (*Lagomys*, Cuv.), figured by Pallas; and, on careful examination, found that it

very nearly accorded with *Lagomys Alpinus*, which inhabits the loftiest rocks of Siberia. It, however, did not exactly agree, either in its size or proportions, with any known species.

An enormous quantity of the bones of the water-rat exists also in this breccia, as well as of some smaller animal, perhaps the land-mouse, *Mus terrestris*, Linn.

Among the fossil animal remains of Dalmatia, M. Cuvier has only been able to find those of ruminating animals. Teeth which are in the Museum of Natural History, and others in the possession of M. Faujas and of M. Camper, appear to be of the size of those of the deer, and perhaps belong to the same animal whose remains are found at Gibraltar. Mr. John Hunter's account of these bones agrees with that of M. Cuvier; but Mr. Hunter states, that among these bones he discovered the os hyoides of a horse.

Spallanzani, from whom alone we have obtained a particular account of the fossils of Cerigo, *Memoires de la Société Italienne*, Tom. III. p. 439, very loosely, and most probably erroneously, describes the deposit as a mountain, in the form of a truncated tone, which is named the *Mountain of Bones*, and which he hyperbolically describes as being full, inside and outside, of animal remains. His description of the state of the bones, and of the nature of the breccia, appears, however, to agree exactly with those of the places already spoken of. With respect to the nature of the bones, he has assumed, evidently on very indifferent authority, that they are human; but there does not appear any reason for supposing that they are different from those which have been already mentioned.

The fossil bones of Arragon appear, from Mr. Bowles's account, to be chiefly of herbivorous animals, of different sizes; but these do not appear to have yet been subjected to a correct anatomical examination. Those which have been found in the Veronese, appear to belong to oxen and stags.

The conclusions which M. Cuvier thinks himself warranted to form,

respecting these phænomena, are, " 1. The osseous brecciæ have not been produced by either a tranquil sea, or by a sudden irruption of the sea. 2. They are even posterior to the last resting of the sea on our continents, since no traces are found in them of any sea-shells, and they are not covered by other beds. 3. The bones and the fragments of stone fell in the clefts of the rocks, successively, and as they fell, became united together by the accumulation of the spathose matter. 4. Almost all the stones proceed from the rock, even those in the clefts which contain the breccia. 5. All the bones, properly ascertained, are those of herbivorous animals. 6. The greatest number of them belong to known animals, and even to animals still existing in those parts. 7. The formation of these brecciæ, therefore, appears to be modern, in comparison with the great regular beds of stone, and with the alluvial beds which contain the bones of unknown animals. 8. It is nevertheless still ancient, with respect to us, since nothing shows that such brecciæ are formed at the present day; and some of them, as those of Corsica, contain also the remains of unknown animals. 9. The most striking character which this phenomenon presents is rather the facility with which certain rocks have been thus divided by clefts, than the matters with which these clefts are filled. 10. This phenomenon is very different from that which is yielded by the caverns of Germany, which contain the bones of carnivorous animals only, spread on the ground, in a mould partly earthy and partly animal; although the nature of the rocks in which these caverns are formed appear to be not very different from those which contain the ossiferous brecciæ."

At Plate XX. Fig. 4, is the representation of a part of a jaw of some ruminant, seemingly of a stag, imbedded in the reddish calcareous mass of Gibraltar.

LETTER XXVI.

FOSSIL REMAINS OF ELEPHANTS.....FREQUENTLY FOUND.....MANIFEST THE EXISTENCE OF ONE OR MORE FOSSIL SPECIES.

The family of Pachydermata, *Crassipelles,* distinguished by the great thickness of the skin, by having more than two hoofs, and, except in the elephant, by having all the three kinds of teeth, is divided into the following genera :—1. *Hyrax,* Cape marmot ; 2. *Sus ;* 3. *Tapirus ;* 4. *Rhinoceros ;* 5. *Elephas ;* 6. *Hippopotamus.* To which may be added two other genera, the fossil remains only of which have been discovered. These have been named by Cuvier *Palæotherium* and *Anoplotherium.*

Theophrastus knew of the existence not only of lapidified bones, but of fossil ivory, *Plin.* lib. xxxv. cap. 18. The enormous bones related by Herodotus to have been found at Tegea, *Herod.* lib. i. sect. 68, as well as those at Caprea, *Suet. Ann.* sect. 72, were doubtless the bones of elephants. The bones mentioned by Strabo, on the authority of Gabinius, *Strab. Geogr.* lib. xvii. were, in all probability, of the elephant, or of some cetaceous animal.

Numerous remains of elephants have been found in Italy ; and although a very considerable number of elephants were brought from Africa into Italy, yet the vast extent through which these remains have been found, and the great probability that the Italians, particularly the Romans, would have known sufficient of the value of ivory, to have

prevented them from committing the tusks to the earth, lead to the belief that by far the greater number of these remains which have been dug up, have been deposited here, not by the hands of man, but by the changes which, at least, the surface of this globe has undergone, at very remote periods. The circumstances, indeed, under which many of these have been found, afford indubitable proof of this fact.

In France, where it is well known that living elephants have been much less frequent, at least in times of which we have any record, than either in Italy or in Greece, their fossil remains have been found in a great number of places, and in situations which prove their deposition at a very remote period. The whole valley through which the Rhine passes, yields fragments of this animal, and perhaps more numerously on the side of Germany than on that of France. Not only in its course, but in the alluviæ of the several streams which empty themselves into it, are these fossil remains also found. Thus Holland abounds with them, and even the most elevated parts of the Batavian Republic are not exempt from them.

The whole of Germany and of Switzerland appear to particularly abound in these wonderful relics. The greater number which has been found in these parts is, perhaps, as is observed by M. Cuvier, not attributable to their greater abundance, but to the number of well-informed men, capable of making the necessary researches, and of reporting the interesting facts they discover.

As in the banks of the Rhine, so in those of the Danube, do these fossils abound. In the valley of Altmühl is a grand deposit of these remains. The bones which have been found at Krembs, in Sweden; at Baden, near Vienna; in Moravia; in different parts of Hungary and of Transylvania; at the foot of the Hartz; in Hesse; at Hildersheim; all appear to be referable to this animal. So also are those which are found on the Elbe, the Oder, and the Vistula. Different parts of the British empire are not less productive of these remains.

In London, Brentford, Harwich, Norwich, Gloucestershire, Staf-

fordshire, Warwickshire, Salisbury, the Isle of Shepey, and indeed in several other parts of Great Britain, have different remains of these animals been found.

When we add to those places which have been already enumerated, Scandinavia, Ostrobothnia, Norway, Iceland, Russia, Siberia, Tunis, America, Hue huetoca, near Mexico; and Ibarra, in the province of Quito, near Peru; it will appear that there is hardly a part of the known world, whose subterranean productions are known to us, in which these animal remains have not been found. *Ann. du Mus.* Tome VIII. p. 1.

Notwithstanding the frequency with which the fossil remains of elephants have been found, there are hardly any fossils of a known genus of animals, respecting which so many mistakes have been committed. At no very remote period, not only the bones, but even the teeth, have been considered as the remains of a gigantic race of men: and Aldrovandus, Kundmann, and others, have mistaken the fossil teeth of elephants for those of other animals. Leibnitz, who wrote in 1749, gives, in the twelfth plate of his *Protogœa*, the engraving of an elephant's grinder, which he describes as *Dens animalis marini;* and even M. de la Metherie, in his excellent work, published so lately as the year 1797, describes a tooth found in Dauphigny, as belonging to an elephant of Africa, which Cuvier has since shown to be a tooth of the great tapir: and the same author considers the teeth from the Ohio, and those brought from Peru by Dombey, to be those of the African elephant*; whilst, as M. Cuvier observes, the fossil teeth of Dauphigny, of Peru, and of the Ohio, not only have no resemblance with each other, but are all totally different from those of the African elephant. So far, indeed, have mistakes respecting the remains of the elephant proceeded, that Kircher, Mercatus, and Aldrovandus, have described the fragment of elephants' teeth as petrified hands *(chirites)*. Kundmann went so far as to insist, not only that one of these fragments

* Theorie de la Terre, Tome v. p. 200 and 201.

was the petrified paw of a large baboon, but that the skin, flesh, nails, and veins, were all discoverable in it, in a petrified state*. Even the accurate Walch refers to this specimen as a real petrifaction of the ape†.

I must here suggest to you the propriety of referring, previous to our examination of these fossil remains, to the ingenious observations of Mr. Home and of Mr. Corse, on the formation of the teeth of the elephant. *Philos. Trans.* 1799. By an attention to these observations, we are of course enabled to form a more correct judgment as to their fossil remains.

From the information thus gained we learn, that the bodies of which we have just spoken, and which the older oryctologists considered as petrified hands, were the separated plates of which the grinders are composed: the more extended parts of these productions having been supposed to be the fingers. The unorganized and looser substance of the cortical crust disintegrates sooner than the two substances of which the plates are formed; hence, in most fossil teeth, this substance is in a very loose state, and in some it has been quite removed, and has left the plates entirely unconnected.

It is but at a very late period that the specific differences of the teeth of the East-Indian and African elephant have been attended to. These differences consist in the form and number of the plates. In the East-Indian, the two wide surfaces of the plates are flat, and covered with numerous rough longitudinal striæ; whilst, in the African, there is on both of the wide surfaces an angular projection through their whole length, and the striæ are much less numerous. The masticating surface shows that the transverse bands, which in the tooth of the East-Indian elephant are straight, and all through of an equal width, are, in the tooth of the African, more in the form of a lozenge; or, much wider in the middle than at their ends. From these lateral projections, the African teeth must necessarily have much fewer plates than the East-Indian.

* Rarior. Nat. et Ant. Pl. III. Fig. 2.

† Monumens des Catast. Tome II. Part 2, p. 150.

The females of the East-Indian elephants have but short and small tusks, projecting obliquely downwards. The African elephants, both male and female, appear to have large tusks. The degree, and even the direction of the curvature of these tusks, vary considerably.

M. Cuvier is satisfied, from actual comparison of several skulls of the East-Indian and African elephants, that different specific characters exist in their respective skulls. In the Indian elephant, the top of the skull is raised in a kind of double pyramid; but, in the African, it is nearly rounded. In the Indian the forehead is concave, and in the African it is rather convex. Several other differences exist, not necessary to be here particularized, which seem to be fully sufficient to mark a difference of species.

A cursory view is sufficient to enable us to determine that the ordinary fossil teeth of elephants are not of the African species; and it may be further said, that the greater number of these teeth bear a close resemblance to the East-Indian species, showing, on their masticating surface, bands of an equal thickness through their whole length, and rudely crenulated. So great, indeed, is the resemblance, that Pallas, and most other writers, have considered the fossil elephant as being of the same species with the Asiatic.

That the fossil elephants were specifically different from the Asiatic elephant, M. Cuvier had been long of opinion; and although the observations of his friend, M. Adrian Camper, made him for a time hesitate, he became confirmed in his opinion from the circumstance, that he almost always found the plates, in the fossil species, thinner, occupying sensibly a less space; and being, consequently, in greater number, in the same length, than in the recent teeth. From this difference in the thickness of the plates, it follows that the number of these plates which are brought into action at once, should be greater in the fossil than in the Asiatic. Mr. Corse observes, that in the latter there are seldom more than ten or twelve in use at once; but in the fossil teeth, there are frequently twenty-four. M. Cuvier

figures one found in the forest of Bondy, in which there are twenty-two. A second distinctive character, according to M. Cuvier, is, that the lines of enamel are thinner, and less scalloped or crenulated, in the fossil, than in the others, he having only noticed one exception. A third character is, he thinks, yielded by the much greater absolute, as well as proportional, width of the fossil, this being in the proportion of eight to six.

The specimens which I possess do not, except as to the greater degree of thickness of the teeth, exactly accord with these observations of M. Cuvier. This is, I believe, in consequence of my happening to possess some fossil teeth, of different species from those in the possession of that gentleman, or from those which I have seen described.

As to the greater thinness of the plates in the fossil than in the recent species, this is, I think, undoubtedly the case, not only with the common fossil teeth, as appears in three or four detached teeth from Essex, and in one which is still retained in its alveolous, in a jaw nearly perfect; but it is also the case with the undulating plates of two other teeth, of which I shall soon have occasion more fully to speak. In the one which is still retained in the jaw, seventeen plates are seen in ten inches extent of surface, all of which were in use at the death of the animal: and, in the two last-mentioned, lamellæ equal to twenty plates exist in a length of triturating surface of six inches and a half. One of these is represented Plate XX. Fig. 8. In a fragment of an upper tooth from Germany, in the length of five inches, are contained only eight lamellæ.

But the specimen which offers the strongest exception to the greater degree of thinness of the plates existing in the fossil teeth being admitted as a general rule, is represented Plate XX. Fig. 6, being a tooth of the left side of the upper jaw, which I purchased from Mr. George Humphries, in the sale of the Calonnian Museum, and which is described as having been found in Staffordshire.

This curious fossil differs materially, not only from the teeth of the

living species of elephants, but also from every fossil tooth of which I have heard. Its peculiarities of character are, the great thickness of the plates, the smoothness of the sides of the line of enamel, and the appearance of the digitated part of the plates, even in the anterior part of the tooth.

The length of this tooth, which is formed of thirteen plates, is eight inches; and the length of its triturating surface, on which are the terminations of nine plates, is six inches. The width of these plates may therefore be taken at nearly double that of the plates of fossil teeth in general; since, in a fossil tooth from Wellsbourn, in Warwickshire, twenty plates exist in the length of six inches and a half; and, in a tooth from Essex, in a length of eight inches and a half, are contained twenty-four plates.

The uncommon smoothness of the sides of the enamel in this fossil teeth, not only appears on its horizontal section, but, the cortical crust having been removed, by decomposition, from between the plates, the great degree of smoothness of their sides is rendered evident.

On almost every triturating surface of the fossil teeth of elephants, except, indeed, when a tooth is first brought into action, full three-fourths of that surface, anteriorly, will be found to be supplied with the plates rubbed down into single bands, passing quite across the tooth; whilst the remaining one-fourth of the surface is filled with detached rings or points, formed by the digitated processes of the plates. But in this tooth the reverse of this is to be seen. Only two entire bands exist, possessing, on the anterior part, about one-fourth of the surface: the remaining three-fourths being occupied by the terminations of the digitated processes.

Taking all these circumstances into consideration, I think there is every reason for considering this tooth rather as belonging to a different species from any which has been hitherto noticed, than to regard it as an anomalous formation of a tooth belonging to the known fossil species. This opinion is founded on four important characters; the great width

of the bands, the thickness of the plates of enamel, the smoothness of their sides, and the great depth to which the notches forming the digitated processes extend. So strong, indeed, are all these characters, and so nearly do the upper terminations of these plates approximate to the protuberances on the grinders of other animals, and particularly of the mammoth, as to give room for the conjecture, that this tooth may have belonged to an animal, possessing intermediate characters between those of the elephant and those of the mammoth.

The specimen, the surface of which is represented Plate XX. Fig. 5, also varies considerably from the recent as well as from the common fossil teeth, in the form and arrangement of its plates This tooth, an upper tooth of the left side, which I purchased at the sale of Rackstrow's Museum, was described in the catalogue as having been taken up with ballast from the bottom of the Thames.

Of the variation which takes place in the form and arrangement of the plates in this tooth, it is very difficult to give a description. In the recent teeth, and in the common fossil teeth, the plates are continued straight across the tooth, the enamel being disposed in a long elliptical line, in which the osseous part, or the ivory of Mr. Home, is included. Hence, by the abstraction of the surrounding crusta petrosa, as we have already seen, frequently is the case with the fossil teeth, the tooth falls to pieces, and each flat plate is found separated. But in the specimen, which has been just examined, an irregularity may be observed in the third anterior row of the plates, where the two digitated processes of a plate passing over little more than half the width of the tooth are interposed between the second and fourth plate, and thrust a portion of the latter plate rather aside. It is an extension of this peculiarity of form which, in part, characterizes the present tooth, since very few of the plates, of which it is formed, pass directly across: leaving it difficult to say, how the osseous part is disposed.

But the most characteristic peculiarity of this tooth is, the continuity of many of its plates, and the remarkable Dædalian line in which the

enamel is disposed. This occurs most particularly in a space in the anterior part of the surface. Here one deeply undulating line of enamel forms the parietes of one wide and deeply indented compages of osseous matter, occupying, as may be seen by the figure, the space of four or five plates. It is very evident that this tooth could not, upon the decomposition of the crusta petrosa taking place, divide, in this part, into detached flat plates, as in the teeth of the recent and of the common species of fossil elephants. This structure is also observable in the fossil tooth from Wellsbourn, which has been already noticed.

This extraordinary structure also exists in the curious and interesting specimen, Plate XX. Fig. 7. This tooth, with the locality of which I am unacquainted, having purchased it at the sale of Mr. Forster's collection, is one, which must have been on the point of being excluded from its alveolus ; the plates on its fore part being entirely worn away, and, of those on the posterior part, some very shallow portions only remaining. These, however, are sufficient to show, that the plates in this tooth were formed and arranged in a similar mode with those of the preceding tooth.

In the fore part of this tooth, from which the plates have been removed, is a very smooth and polished surface of a thin coat of the crusta petrosa. This is, indeed, so thin, that at the root of the small projecting piece of enamel, in nearly the middle of the tooth, a small part is discoverable, where the crusta petrosa itself is worn through, and a portion of the substance of the root itself has been acted upon. Behind this, are two detached bands, linearly and transversely disposed. Just above the upper part of one of these commences a line of enamel, which proceeds in undulations for the space of two plates, through half the width of the surface, the remaining half being filled up by two separate terminations. The line of enamel then passes on, by deep undulations, to the back part of the tooth, filling up the space of three more plates. This peculiarity of structure will however be better understood from the figure, than it can be from even the most exact description.

This specimen is particularly interesting, from the circumstance of its showing that this particular modification of the arrangement of the enamel takes place in the part of the tooth nearest to the root, as the other specimens, that from Wellsbourn, and that whose surface is represented Plate XX. Fig. 5, show that it exists in the crown of the tooth. From this peculiarity of structure being found to exist in three different specimens, I conceive that it cannot be regarded as an accidental difference; and from the considerable difference which exists between this arrangement of the enamel and that which occurs in the teeth of the living species, and of the common fossil species, I trust it will be admitted as being likely to be one of the characteristics of a species which has not yet been remarked.

M. Cuvier, anxious to discover the degree of accordance of the fossil elephant's skeleton with that of the living species, compared the fossil skull found in Siberia by Messerschmidt, a figure of which is given by Breyn, in the fortieth volume of the Philosophical Transactions, with those of the African and Asiatic elephants. The result of his comparison was, that in the fossil species the alveoli of the tusks are much longer; the zygomatic arch is of a different figure; the post-orbital apophysis of the frontal bone is longer, more pointed, and more crooked; and the tubercle of the os lachrymalis is considerably larger, and more projecting. To these peculiarities of the fossil skull, M. Cuvier thinks, may be added the parallelism of the molares.

The lower jaws of the fossil species of elephants accord with the peculiarity of form observable in the skull. From the teeth in this, as well as in the upper jaw, being placed nearly parallel with each other, the vacuity between the branches of the jaw, at its fore part, is wider, in proportion to its length, than is the case in either the Asiatic or African jaws. In the existing species of elephants the lower jaw terminates in rather a pointed apophysis, room to admit of the motion of which is yielded by the separation of the tusks. But in the fossil skull the alveoli of the tusks descend much lower, so that they would

interfere with the motion of the lower jaw, unless prevented by some accordant modification of its structure. This is found to exist; the lower jaw being so rounded off in the front, as to allow of its motion behind the descending alveoli. Both these circumstances are observable in the fossil jaws examined by M. Cuvier, and also in two portions which I obtained from Essex.

This structure must have materially affected the form of the face and the organization of the trunk, and must have given the animal a very different appearance from that which is borne by the Asiatic elephants. It must be, however, admitted, that the jaw-bone mentioned by M. Adrian Camper shows, that there does exist an elephant which possesses certain characters different from those of the known living species, and approaching to those which at present mark the fossil species. M. Adrian Camper, it must be added, informs his friend Cuvier, that he possesses a jaw-bone of an elephant of Ceylon, which differs much from the other recent jaws which he has seen, and very closely agrees in its dimensions with the fossil jaw-bones.

Comparing together the bones of the Asiatic and of the African elephant, he was able to discover some differences between them, as well as between those and some of the fossil bones which he possessed. These latter he found, in general, approached nearest to those of the Asiatic elephant. He concludes with supposing that the fossil remains are of a species differing more widely from the Asiatic elephant than the horse does from the ass, and therefore does not think it impossible but that it might have existed in a climate which would have destroyed the elephant of India.

It may, therefore, be assumed as certain, from the observations of M. Cuvier, that at least one species of elephants has existed, of which none are now known living; and should the difference of structure which I have pointed out, in some of the fossil teeth, be admitted as sufficient to designate a difference of species, it may be then said, that

there exist the fossil remains of, at least, two species of elephants, which were different from those with which we are acquainted.

The structure of the fossil tusks of elephants agrees, as might be expected, exactly with that of the recent. The transverse section shows very small striæ, passing in a circular sweep from the centre to the circumference, across each other, and thus forming curvilinear lozenges, which occupy the whole disk. This structure is truly characteristic of the ivory of the elephant, and, as I shall soon show you, of the mastodon, it not being found in the tusks of any other animal. It is much more plainly observable in the decomposing fossil tusk than in the recent one. This peculiarity of structure is shown Plate XX. Fig. 1, the surface being slightly magnified.

The size of the tusks varies according to the species, the sex, and the age; but no information is yielded respecting the difference of species, by the difference of size in the fossil tusks. It may, however, be remarked, that they do not appear to exceed in size the tusks, with which the individuals of living species might be furnished, if they were to live to their natural period.

The curvature of many of the fossil tusks agrees with that of the living species, but the curve of the greater number approaches nearly to a semicircle. Four such have been described; and one of these, by Messerschmidt and Breyn, in the fortieth volume of the Philosophical Transactions. Being apprized, about seven years since, that the remains of some large animal had been found in the brick-fields of Mr. Hobson, at Kingsland, I made the necessary investigations, and learned that a tusk of an elephant had been found between the stratum of gravel and of clay, but in so shattered a state, that only small fragments of it could be removed, and that it therefore had been again covered over. One of Mr. Hobson's clerks, a very intelligent gentleman, favoured me with a fragment of the tusk, which I now possess, and a fossil oyster-shell, which was found near it. He

also obliged me with a sketch, which he had made, chiefly to mark the curvature of the tusk, which appeared to him as very extraordinary. From this sketch, it appears to have formed nearly four-fifths of a circle.

On the other hand, the fragments of a pretty large tusk, which I have from Essex, are sufficiently long to show, that the degree of curvature could have very little exceeded that of tusks in general. Another specimen from Essex, a portion of the smallest end of a pretty large tusk, laterally flattened, appears to have been full as straight as recent tusks generally are. The same was observable of another portion from Essex, which I presented to a friend. A very small tusk, from the same place, is particularly straight: this, however, belonged to a very young, and most probably to a female animal.

From the preceding observations it appears then, that the fossil elephantine remains, notwithstanding their resemblance in some respects to the bones of the Asiatic elephant, have belonged to one or more species, different from those which are now known living. This circumstance agrees with the facts of the fossil remains of the tapirs and rhinoceroses, which appear to have differed materially from the living animals of the same genera. The remains of elephants obtained from Essex, Middlesex, Kent, and other parts of England, confirm the observations of Cuvier, that these remains are generally found in the looser and more superficial parts of the earth, and most frequently in the alluvia which fill the bottoms of the vallies, or which border the beds of rivers. They are generally found mingled with the other bones of quadrupeds of known genera, such as those of the rhinoceros, ox, horse, &c. and frequently also with the remains of marine animals.

LETTER XXVII.

MASTODON.

We now come to the examination of one of the most stupendous animals known, either in a recent or a fossil state; and which, whether we contemplate its original mode of existence, or the period at which it lived, our minds cannot but be filled with astonishment.

The first traces of this animal are sketched in a letter from Dr. Mather, of Boston, to Dr. Woodward, in 1712, and are transcribed from a work in manuscript, entitled *Biblia Americana*. In this work, teeth and bones of a prodigious size, supposed to be human, are said to have been found in Albany, in New England*. About the year 1740, numerous similar bones were found in Kentucky, on the Ohio, and dispersed among the European virtuosos. Buffon, speaking of these teeth and bones, found by M. le Baron de Longueuil, M. de Bienville, and M. de Lignery, says:—"It can never be supposed that these teeth could have been taken from the same head with the tusks."—"In supposing this, it would be necessary to admit the existence of an *unknown animal*, which had tusks similar to those of the elephant, and grinders resembling those of the hippopatamus." *Mem. de l' Acad. Roy. des Sciences*, 1762.

In 1765, several of these remains were found by Mr. G. Croghan, four miles to the south-east of the Ohio, and were conveyed to England. These bones were discovered five or six feet below the surface; and, from the quantity of bones, it was concluded, that there could not be less than thirty skeletons of this animal. Mr. Collinson, in a letter to

* Philosophical Transactions, abridged by Jones, Vol. V. Part II. p. 159.

Buffon, also refers these remains to some large, unknown animal, with the tusks of the elephant and grinders of the hippopotamus. *Buffon*, Tome XIII. Dr. W. Hunter, by whom these remains were examined, and who believed that they belonged to some carnivorous animal, had the satisfaction of comparing the half of a lower jaw of this animal with the jaw of an elephant, and found so great a difference, as convinced him "that the supposed American elephant was an animal of another species, a pseud-elephant, or *animal incognitum*." Presuming that the American bones were not elephantine, the Doctor concluded that the Siberian were of the same kind. *Philos. Trans.* Vol. LVIII. The celebrated Camper, at first, concluded that this animal approached nearer to the elephant than to the hippopotamus; and that it, in all probability, had a trunk, and therefore was not to be considered as carnivorous. But contemplating afterwards some fragments of the skull of this animal, in a wrong point of view, he changed his opinion; and concluded, that this animal must have had a pointed muzzle and no tusks; that it did not resemble the elephant; and that he was unable to determine anything with respect to its real nature. Dr. Hunter, in the paper above referred to, published in 1768, observes, that in the British Museum, and in private collections, he met with grinders of the *incognitum* that had been found in the Brazils and Lima, as well as in different parts of Europe. M. Buffon, in 1778, figured one of these teeth, which he had received from the Count de Vergennes, and which had been found in Little Tartary; also another, which had been brought by the Abbé Chappe from Siberia. *Epoques de la Nature*, Pl. I. II. et III.—Pallas has also given the figure of a tooth of this animal, from the Oural Mountains.

Many bones of this animal having been found, in 1799, in the State of New York, in the vicinity of Newburgh, which is situated on the Hudson, or North River, Mr. C. W. Peale, of Philadelphia, purchased these, with the right of digging for the remainder. In 1801, Messrs. Peale made every exertion to discover more of these remains in the spot

where the former had been found; but although neither labour nor expense was spared, they were not rewarded by finding any of the more important and illustrative parts of the animal. Another attempt was then made in a morass, about eleven miles from the former, where almost an entire set of ribs was found, but nothing more. After this, they searched a morass about twenty miles west from Hudson River; and here, after a series of disappointments, and slight successes, they found a right os humerus, a radius and ulna of the left side, the right scapula, the atlas, a complete under-jaw, and the great object of their pursuit, the upper part of the head, which was, however, so rotten, that they could only preserve the teeth and a few fragments.

From the whole of the bones which they obtained, two skeletons were formed, composed of the appropriate bones of the animal, or exact imitations from the real bones in the same animal, or from those of the same proportion in the other. Mr. R. Peale, who has given a description of this animal, asserts, that there is one bone less in the neck of this animal than in that of the elephant, never having met with a single bone resembling a seventh vertebra of the neck. The dorsal vertebræ were supposed to agree in number with those of the elephant; as nineteen of these vertebræ and as many ribs were found, one in all probability having been lost: three vertebræ were thus left for the loins.

From the formation of the teeth, the disposition of the enamel, the incapacity in the jaw for lateral motion, and from the condyloid process, which is finished with an oblong head, being inserted into a transverse groove, Mr. Peale concludes this must have been a carnivorous animal. The teeth of the upper and lower jaws, when shut, he observes, must have had their points and depressions fit into each other, like the teeth of two saws; and whilst shut must have been immoveable laterally, and consequently incapable of triturating, like the teeth of graminivorous animals.

The roots or fangs of the teeth, Mr. Peale observes, are inserted into the mass of bone, which not only surrounds the roots, but divides one

root from the other; whereas, in the elephant, the grinders occupy one large and uniform cavity, from which they are gradually protruded.

The only instance of hair, Mr. Peale says, being found with the remains of this animal, occurred in a morass belonging to Mr. A. Colden. The hair was coarse, long, and brown; a large mass of it was found together, but so rotten, that, after a few days exposure to the air, it fell into a powder*.

The country in which these remains are found is like an immense plain, bounded on every side by immense mountains. On digging into the morasses where these bones are found, the following strata are generally met with: one or two feet of peat, one or two feet of yellow marle, with vegetable remains; about two feet of grey marle, like ashes; and, finally, a bed of shell-marle. It is in the grey marle that the bones are chiefly found. This marle is found to contain seventy-three parts in the hundred of lime, and when dry will burn for a long time with a bright flame. In the neighbourhood of these morasses are found an infinite number of petrifactions of marine bodies, echinites, corallites, &c. one of which I had occasion to speak of in the preceding volume.

From the accounts of Dr. Barton, General Collard, Mr. Smith Barton, Mr. Jefferson, Mr. Dunbar, and others, it appears that considerable quantities of these remains have been found in different parts, in the neighbourhood of the Ohio, of the Mississippi, and of the Missouri. They have not, however, been yet found higher than the Lake Erie, in

* An account has been given of the discovery of the remains of a mammoth, on the shores of the Frozen Sea, with its flesh, skin, and hair, in good preservation. This account, written by M. Michael Adams, of Petersburgh, was kindly communicated by Sir Joseph Banks to Mr. Tilloch, by whom it was published, in the Philosophical Magazine, Vol. XXIX. p. 141. This discovery excited a considerable degree of attention, which was, however, by many, misdirected; since they should rather have regarded this animal as, perhaps, one of the lost species of elephants, than as a mammoth or mastodon. That it could not have been one of this latter genus is evident, from the account of M. Adams himself, who says, "The mammoth in my possession is quite different from that found near New York, which, from the description, had carnivorous teeth." M. Adams concurring with the Russians, in giving the name of mammoth to the elephants found imbedded in those parts.

about 43° of north latitude. These remains are also found on this side of the three great chains of mountains, the Aliganys, the North Mountains, and the Blue Mountains; in the anterior parts of Pennsylvania and Carolina; and in New Jersey, a few miles from Philadelphia.

Among the more curious discoveries which have been made respecting this animal, is that which is related by Mr. Maddison, of a considerable quantity of bones found in Virginia, near to Green Briar, where the bones of the megatherium were found. The discovery of these bones was accompanied with a circumstance particularly interesting. In the midst of them was found a mass of small branches, grass, and leaves; and among the latter, some of a species of reed, which is at present common in Virginia. These were all half bruised, and appeared to be contained in a kind of bag, which was considered as the stomach of the animal: the contained substances were supposed to have been taken by the animal as food.

The teeth brought from Peru by Dombey and M. de Humboldt, as well as that brought by the latter naturalist from Terra Firma, are, in the opinion of M. Cuvier, of a different species from the North American. He also suspects this to be the case with the teeth from Brazil and Lima, mentioned by Dr. Hunter; and concludes, that these bones, so common in South America, are very rarely found elsewhere.

These bones are always found but at a little depth, and seldom appear to have changed their situations since the death of the animal. Mr. Barton relates two instances, where the soft parts of the animal appear to have been dug up; and the Indians described one of the heads which were dug up in 1762, as having over the mouth a long nose, which Mr. Barton supposes must have been the trunk. Kalm, speaking of a skeleton discovered by the savages of Illinois, says, that the form of a trunk was yet discoverable, although half decomposed.

M. Cuvier informs us that there is at Paris a fragment, which, if the account of it be authentic, would make us doubt whether this species is really extinct. It is part of a foot, with five nails attached to it; and

which the owner of it says, he obtained of a Mexican, who had purchased it of a savage of the West of the Missouri, who had found it with a tooth in a cave. But it being so fresh, appearing also to have been cut off with a sharp instrument, and so perfectly resembling that of an elephant, M. Cuvier is induced to suspect some fraud on the part of the Mexican.

These astonishing remains have, as might be expected, been strictly examined by Cuvier. In the 46th number of the Annals of the Museum of Natural History, this illustrious anatomist has not only given a compendious account of the preceding discoveries which had been made respecting this animal, but has also entered into an anatomical examination of the several parts which have been found.

The grinders, he observes, are formed of two substances only; an internal bony substance, and a thick coat of enamel. The form of their crown is in general rectangular, the hinder ones being rather narrowest behind. The crown is divided, by widely spreading grooves, into a certain number of transverse risings, each of which is divided, in the contrary direction, into two large obtuse and somewhat quadrangular and pyramidical points, the whole crown, when not worn, being beset with large points, disposed in pairs. In consequence of several of these teeth being much worn down, not only to the base of the pyramids, but even so low as only to leave one square surface edged with enamel, it has been inferred that they have been employed in the trituration of vegetable substances. The roots of these teeth being formed after the crown, they are not found complete until the crown has begun to be a little worn.

M. Cuvier particularizes three sorts of these grinders: nearly square, with three pair of points, generally much worn; rectangular, with eight points, which are less worn; and others still longer, with five pair of points and a single smaller one, which are seldom worn in the least. These appearances agree with their situations; those with three points being the foremost, and appearing the first; whilst those with ten are the hindmost, and appear the last.

From observations made on the several lower jaws which have been

found, it appears that the two first sorts of teeth may exist in the mouth of the animal at the same time; but that those of the latter sort follow the others. M. Cuvier says, perhaps there may have been, in the infancy of the animal, a tooth with four points, which would be cast early. This he was led to conjecture, from having been informed by M. de Beauvois, that in a jaw belonging to Dr. Barton, there appeared to be the marks of an alveolus before the tooth with six points. There can be little doubt but that the teeth succeeded to each other, as in the elephant: there never, however, being more in the mouth, at once, than two, and at last only one.

For want of attending to this succession of the teeth, and supposing many of these teeth to have existed in the mouth at the same time, very erroneous conjectures have been formed respecting the size of this animal. Thus Buffon observes, that the square form of these enormous grinders prove, that several were in the jaw at the same time; *Epoques de la Nature, Notes justif.* 9. But, if we suppose there were six, or even four, on each side of each jaw, how enormous must that head have been, which contained at least sixteen such teeth. Reckoning on these fallacious grounds, he concludes, the animal must have far exceeded the size of the largest elephants; whereas, we have no proof at present of this animal reaching to twelve feet in height, whilst, agreeable to Buffon's own account, the Asiatic elephants are sometimes fifteen or even sixteen feet high.

One of the back grinders of this animal, with five pair of points, and an odd one at the end, is represented in the frontispiece to this volume. This tooth is in remarkably fine preservation, and was for several years a part of the collection in this city, which was called Rackstrow's Museum. It is seven inches and a half long, eighteen inches in circumference round its crown, and it weighs four pounds seven ounces.

The remains of the under-jaw of this animal show us that, like the elephant and morse, it had neither canine nor incisive teeth; that it terminated in the fore part, as in those animals, in a hollowed point,

which was, however, much shorter and less acute than in the elephant; that the posterior angle, although obtuse, is defined, and not rounded off as in the elephant; and that the arms or branches of the jaw, formed of the condyloid and coronoid processes, and their bases, are shorter and flatter than in the elephant, as is required by the peculiar form of the upper jaw.

No perfect specimen of the skull of this animal has been hitherto found; but, from the fragment in the possession of M. Camper, and from that of Mr. Peale, it appears, 1. That in the mastodon the grinders, in the upper jaw, diverge forwards; whereas, in the common elephants, they converge more or less; and in the fossil elephant, or mammoth of the Russians, they are nearly parallel. The hog and the hippopotamus approach the mastodon a little in this respect. 2. The bony palate extends considerably beyond the last tooth. The Ethiopian sow is the only herbivorous animal which resembles the mastodon in this respect. 3. The pterygoidal apophyses of the palate-bones are of a thickness unparalleled among the quadrupeds. 4. The notch before this apophysis has some agreement with that of the hippopotamus, which is, however, narrower. 5. That there is no trace of any orbit in the zygomatic arch; but that where the orbit occurs, in the elephant, is a large mass of bone; so that the eye must have been placed much higher in this animal than in the elephant. 6. That the maxillary bones have a less vertical elevation than in the elephant. 7. That, hence, the zygomatic arch is less raised behind, agreeable to the conformation of the lower jaw; and, of course, the position of the ear varies from that which takes place in the elephant. 8. From this proportion results the difference in the situation of the occipital condyles in the two animals; they being raised considerably above the level of the palate in the elephant, and nearly on the same level with it in the mastodon. With respect to the large cells, from which proceeds so great a degree of thickness in the skull of the elephant, there seems to be every reason for supposing that these existed in a similar manner in this animal. Of

the form of the head nothing certain is as yet known; but it appears to have been proportionally longer than that of the elephant.

Mr. Peale was the first who ascertained that this animal was provided with tusks, by discovering the remains of a skull already mentioned, in which the alveoli were evident. These tusks resemble those of the elephant; they are inserted in the incisive bone, and are composed of ivory, the grain of which shows curvilinear lozenges, enveloped by a substance, which is not of the texture of ivory, but is formed of fibres converging towards the centre; and which, though less hard than the enamel, seems very nearly to resemble that substance. Mr. Peale had been disposed to place the tusks of this animal in a situation the reverse of that which they hold in the elephant; that is, with their convex part forwards, and the point turning backwards; but no circumstance but the finding a skull, with the tusks thus disposed, can authorize the placing of them different from those of the elephant.

From the circumstance already noticed, and from every consideration of the subject, there appears to be no reason for doubting that this animal had a trunk like the elephant, with whom it agrees in so many respects.

The form of the vertebræ agrees in general with that of the corresponding vertebræ in the elephant. The ribs are formed different from those of the elephant, being thin towards the cartilage, and thick and strong towards the back. The six first pair are very strong in comparison with the others, which also become, proportionally, very short: which circumstance, taken with the depression of the pelvis, shows that the belly was less voluminous in this animal than in the elephant.

The scapula appears to possess the characters of the scapula of the elephant, and particularly the recurrent apophysis peculiar to this genus, and to the rosores *(rongeurs)*. The scapula seems to be narrower than even that of the African elephant, and to have the recurrent apophysis placed higher than in the Asiatic elephant. The length of the scapula is three feet and one inch. Mr. Peale describes the acromion as being

long and pointed. The long bones of the fore extremity are, according to Mr. Peale, much thicker in proportion than those of the hind extremity; and this difference is greater than what exists in the elephant. The humerus, agreeably to the observations of M. Cuvier, is shorter, and the fore-arm longer, in proportion, than they are in the elephant. The humerus also is shorter, in proportion, to the scapula.

The pelvis is much more depressed, in proportion to its width, than in the elephant: its opening is also much narrower.

The enormous mass of the os femoris, and particularly its width, which exceeds that of both the existing and the fossil elephant, excites astonishment immediately on being seen. It is flatter from the fore part backwards, at its lower end, in consequence of the groove answering to the rotula being shorter. The tibia, in the opinion of Mr. Peale, is less in proportion, in this animal, than the elephant. The observations of M. Cuvier do not corroborate this opinion; but rather prove, that the proportions here were nearly alike in both animals.

Mr. Peale observes, that the bones of the hind feet are remarkably smaller than those of the fore feet, as is likewise the case in the elephant. The second phalanges of the fore feet, he observes, terminate in surfaces, which seem to show that the bones of the third, or ungual phalanx, had more motion than they have in the elephant, and approached nearer to those of the hippopotamus.

From a careful attention to every circumstance, M. Cuvier conceives that we have a right to conclude, that this great mastodon, or animal of the Ohio, did not surpass the elephant in height, but was a little longer in proportion; its limbs rather thicker; and its belly smaller. It seems to have very much resembled the elephant in its tusks, and indeed in the whole of its osteology; and it also appears to have had a trunk. But notwithstanding its resemblance to the elephant, in so many particulars, the form and structure of the grinders are sufficiently different from those of the elephant, to demand its being placed in a distinct genus. From the later discoveries respect-

ing this animal, he is also inclined to suppose that its food must have been similar to that of the hippopotamus and the boar, but preferring the roots and fleshy parts of vegetables; in the search of which species of food it would, of course, be led to such soft and marshy spots as he appears to have inhabited. It does not, however, appear to have been at all formed for swimming, or for living much in the waters, like the hippopotamus, but rather seems to have been entirely a terrestrial animal.

Other teeth, bearing a very close analogy with those of the animal of the Ohio, have been long noticed by different authors; but it is to M. Cuvier that we are indebted for collecting and comparing the different accounts which have been given of teeth belonging to this genus, but which have been found in different places on the two continents, and are of a different species than those of the Ohio.

Dr. Grew, in 1681, in his History of the Rarities of Gresham, Plate XIX. Fig. 1, figured the upper part of one of these teeth, which he describes as the petrified tooth of a marine animal. Reaumur figured part of a tooth from Simorre, in Gascony, somewhat resembling this, in the Memoirs of the Academy of Sciences, for 1715. D'Argenville has figured an entire tooth resembling these, *Oryctologie*, Pl. XVIII. Fig. 8, and which he described as having belonged to some unknown fish. A similar tooth is also represented in Pl. VIII. of the Supplement to Knorr's work. J. Baldessari, in 1767, described and figured, in the Memoirs of the Academy of Sienna, Tome III. p. 243, two considerable portions of a lower jaw found at Monte Follonico, and considered them as similar to those described by M. Guettard. A tooth of this kind, of a large size, was found in 1784, at Trevoux, and considered by M. de Morveau, *Mem. de l'Acad. de Dijon*, Tome VI. p. 102, as being of the same species as those from the Ohio.

Besides these now mentioned, M. Cuvier was surprised to find, by his correspondence, that these teeth were not unknown in several other parts of Europe and America. In Sort, near to Dax; Montabusart, near to Orleans; Saxony; Asti, in Piedmont; the Vale of Arno;

different parts of Lombardy; Peru; the Field of Giants, near Santa-Fe, in Terra-firma; and in the province of Chiquitos, in Paraguay, have teeth, which are referable to this genus of animals, been found. Besides the teeth found in these different parts, he obtained information respecting several others, of which the places where they had been found were unknown: the whole being so numerous, as to show that this race of animals had left a considerable quantity of their remains.

From the general form of these teeth, from bones being found with them resembling those of the mastodon of the Ohio, and from their being reason for supposing that they were accompanied by tusks, no doubt can be entertained of their having belonged to this genus. But these teeth possess also other specific characters, which sufficiently distinguish them from those of the Ohio. The chief, and the most general of these, are, that the cones of their crowns are more or less deeply grooved, that they are sometimes terminated by several points; and that they sometimes are accompanied by other smaller cones, placed on the sides, or in the intervals of the larger cones. In consequence of this formation, as the crowns of these teeth are worn down by mastication, small circles, and then three-lobed, or club-like figures, appear where the points were, but not the lozenge-formed figures which these parts assume in the animal of the Ohio. From these club-like markings Daubenton, P. Camper, and M. Faujas, have been disposed to consider these teeth as resembling those of the hippopotamus: from which, however, they may be distinguished, independent of their greater size, by their having six or ten of the club-like markings; whilst, in the teeth of the hippopotamus, there are never more than four. The distinguishing of these smaller teeth from each other, was a task of much greater difficulty and labour, but has been in a great measure accomplished by the assiduous investigations of M. Cuvier.

From these researches he has been enabled to distinguish five species of this genus, which he thus designates: 1. The mastodon of the Ohio. 2. The mastodon with narrow teeth, found at Simorre and elsewhere.

3. The small mastodon, that with small teeth. 4. The mastodon of the Cordilleras, the large animal with square teeth. 5. The mastodon of de Humboldt, which is the smallest.—No individual of either of these species is at present known to exist.

Of the teeth of the second of these species, that with narrow teeth, he obtained the examination of specimens from Sort, near Dax, Simorre, Peru, Monte Follonico, Irevous, La Rochetta di Tanaro, near Asti; Arno's Vale, and the Field of Giants, near Santa-Fe.

From a careful comparison of these specimens, he was able to determine these detached but important facts. First, that in a specimen of the upper jaw of this animal there had been three teeth, the foremost having four points, and one at the hinder part; the middlemost six pair of points, with two supplementary behind; and the hindmost divided in six rows of eminences, all subdivided in two, except the last. Secondly, That these teeth were pressed from behind forwards, as in the elephant and in the mastodon of the Ohio, and that the fore-teeth disappeared at a certain period. He also found reason for supposing that the fore-tooth was capable of being replaced from beneath, as in the hippopotamus. Thirdly, That the lower jaw, in its fore part, terminated in a kind of beak, like that of the elephant, and of the large mastodon; there being neither canine nor incisive teeth.

In the lower teeth the outer side is most worn, and consequently the inner is most projecting, the contrary being necessarily the case with the upper teeth: hence the outer points of the lower teeth obtain the club-like markings and the inner points of the upper. This is agreeable to a general law in the herbivorous animals, that when the two sides of a tooth are not similar, they are placed contrariwise in the two jaws. Thus the ruminants have the convex part of the crescents of their upper teeth inwards, and that of the lower teeth outwards.

The situation and form of the supplementary points in the different teeth of this animal, and the points assuming the club-like markings on being worn down, show some analogy between these and the teeth

of the hippopotamus. Compared with the mastodon of Ohio, these teeth are so narrow, as certainly to warrant the distinguishing of the animal to which they belong, as the *mastodon with narrow teeth.*

A tooth from Saxony, formerly sent to Bernard de Jussieu, and another from Montabusard, were found to correspond in their figures and proportions with the preceding species, but were exactly one-third less. Knowing no instance of such a difference of size in any species of wild animals, and as this difference could not depend on age, since the teeth grow no more after being once formed, M. Cuvier had no hesitation in considering these as of a distinct species—that which he has named *the small mastodon.*

M. de Humboldt found a tooth near to the volcano of Imbaburra, in the kingdom of Quito, at the height of 1200 toises. It is considerably decomposed, and partly coated with volcanic cinders. The same celebrated traveller found another of this species on the cordilier of Chiquitos, between Chicas and Tarija, near Santa-Crux de la Sierra, in 15 deg. S. L. M. Alonzo also furnished M. Cuvier with a drawing of another tooth from the same province of Chiquitos. These teeth all appear to have belonged to the same species of animal. Their characters appear to be that of being of a square form, and having the same proportions with the teeth with six points belonging to the mastodon of the Ohio; and so resembling them, that they might be mistaken for them, were it not for the club-like figures which their points assume, and which cannot be mistaken for the lozenge-like figures observable in the teeth of the latter animal. The teeth thus characterized he distinguishes as the *mastodon of the Cordilleras.*

To M. de Humboldt we are also indebted for another tooth, evidently of another species. This tooth, like those of the preceding species, is square, but is a third less in size; bearing the same proportion to those of the preceding species as the teeth from Saxony and Montabusard bear to the species with narrow teeth from

Simorre, &c. This tooth was found in the neighbourhood of the City of Conception, in Chili. This is the tooth on which M. Cuvier establishes his species of the *mastodon of de Humboldt.*

At Harwich, as well as at the next promontory of Walton, blue clay appears, and most probably extends through the whole of the intervening marsh. At Walton, by digging in different parts of this stratum, and by the action of the waves against its edge, the bones of several large animals have been discovered. These I have ascertained to belong to the ox, stag, Irish fossil elk, hippopotamus, rhinoceros, and elephant, of which mention was made in the preceding letter.

But both at Harwich and at Walton are prodigious beds of fossil shells, highly ferruginous, and reaching thirty or forty feet above the clay stratum. Dispersed in these beds of fossil shells, polished bowldered fragments of bones are frequently found, which, like the shells, are strongly impregnated with iron; so much so, as to have acquired a very considerable degree of hardness, and to emit a sharp ringing sound when struck against any hard body. These fragments of bones being washed by the waves out of their matrix, are frequently found on the beach.

From the smallness of these fragments, few being above six inches long, and hardly any possessing twelve inches in length; and from their being almost all reduced to one shape by bowldering, previously to their being placed in their present bed, no grounds have existed, on which any opinion could be founded as to the animal to which they belonged. But within these last few years, a tooth was found on the beach at Harwich, possessing the colour and appearance of the fragments of bones so strongly, as to leave no doubt of its having been imbedded in the same bank of shells. This tooth was shown to me by my much lamented friend and companion in these pursuits, Dr. Menish, by whom, at my request, it was shown to the members of the Geological Society. Its figure had been much injured by

attrition; so that, although no doubt could be entertained of its having belonged to an animal of the genus *Mastodon*, I think that no opinion could be formed respecting its species; but on this point I speak with hesitation, since, at the time I saw it, I was unacquainted with the existence of more than one species of this fossil.

LETTER XXVIII.

FOSSIL REMAINS OF THE RHINOCEROS..............FOSSIL ANIMAL DIFFERENT FROM THE RECENT SPECIES......HIPPOPOTAMUS.......FOSSIL REMAINS..........SMALL FOSSIL HIPPOPOTAMUS, AN UNKNOWN SPECIES........FOSSIL ANIMALS APPROACHING TO THE TAPIR.

An accurate knowledge of the anatomy and of the number of species of the rhinoceros has been but lately obtained, and that through the assiduous inquiries of Cuvier. Thus the celebrated Camper, unacquainted with the characteristic differences of the teeth of the unicorn and bicorn rhinoceros, and not finding incisive teeth in the two-horned species, charged Parsons, Linnæus, and Buffon, with error, in supposing them to exist in the one-horned species. But, on examining the living animal of the latter species at Paris, and seeing its incisive teeth, he immediately acknowledged the error into which he had fallen. M. Faujas also, for want of correct notions respecting the teeth of this animal, formed erroneous conclusions as to the number of species.

In every adult rhinoceros there are twenty-eight grinders, seven on each side, at the top and bottom. It must be, however, remembered that, as the teeth of the rhinoceros, like those of other herbivorous

animals, have their roots brought into use when the crown is worn away; and as the root divides into two branches, the two stumps of the roots of one tooth, forced upwards by the filling up of the alveolus, will give the appearance of two teeth.

In the lower jaw are two large incisors, placed at the anterior angle; and between these are two very small incisive teeth, which remain concealed within the gums. There are also two large incisive teeth in the upper jaw; and Cuvier has discovered, that in this jaw also there are two very small incisors, which are disposed, contrary to those of the lower jaw, on the outside of the larger incisors.

The differences observable in separate detached grinders of these animals are not such as will serve to distinguish the species, but merely to point out the age of the individuals. Of course, it is not from the fossil grinders alone that we are able to determine whether the fossil remains of this animal belong to a species which still exists, or to one which is lost. Happily, however, complete information may be obtained on this point from the examination of the whole skull. By a careful comparison of the fossil with the recent skull, it is found that the fossil skulls exactly agree with each other, and belong to one and the same species, and that the fossil species is essentially different from those which are known in a living state.

Omitting to notice the opinions of those who had written on this subject before the necessary anatomical knowledge respecting the living species of this animal was attained and published, I shall place before you a sketch of the observations of M. Cuvier, on the opinions entertained by M. Faujus on this subject.

There appeared to be three living species of rhinoceros: 1. That of *India*, a unicorn, with a rugous coat, and with incisors, separated, by a space, from the grinders. 2. That of the *Cape*, a bicorn, the skin without rugæ, and having twenty-eight grinders, and no incisors. 3. That of *Sumatra*, a bicorn, the skin but slightly rugous, thus far resembling that of the Cape, but having incisive teeth like that of India.

On comparing the skulls of the fossil rhinoceros with those of the existing species, the following differences are observed: 1. The skulls of the fossil rhinoceros are, in general, much larger than those of the living species; but as the skulls of the living species, which have been obtained, may not have been of the largest individuals, this difference is not such as should be insisted upon. 2. The occipital surface, which in the recent skulls is nearly perpendicular with the axes of the head, and which, in the unicorn, even inclines forward, in all the fossil skulls, inclines considerably backwards; which necessarily occasions the distance from the nose to the occipital ridge to exceed considerably that from the nose to the occipital condyles. 3. The *meatus auditorius* has its axis vertical in the living species; but, in consequence of the obliquity of the temporal bones occasioned by the obliquity of the inclination of the occiput, this axis is oblique in the fossil species. 4. The fossil species has two horns, but the skull has nothing of the form of the bicorn of Africa. There is a considerable space between the bases of the two horns in the fossil species, whilst in the rhinoceros of Africa and of Sumatra the bases touch. This difference evidently proceeds from the elongation of the skull in the fossil species. The basis of the second horn, too, agreeable to the remark of M. Adrian Camper, has a more raised, and embossed, and a much more rugous surface, in the fossil, than in the existing species. 5. Instead of the anterior apophysis of the superior maxillary bone being short, and the intermaxillary very small, as in the bicorn of Africa, the fossil bicorn had these parts very strong, and longer than in all the other species, which renders the length of the nasal notch more considerable. 6. There is in the fossil species a prominence on the superior part of the incisive bone, which is not to be seen in the bicorn of Africa, in that of Sumatra, nor in a young unicorn, which appeared to approach to that of Sumatra. It was found only in the large unicorn, the skeleton of which is in the National Museum. 7. The most important character in the fossil rhinoceros is the form of the bones of the nose, and their junction with

the incisive bones: in these respects it differs not only from the other rhinoceroses, but from all other known animals. The point of the nasal bones, instead of terminating in a distinct projection, at a certain distance above the incisives, descends, without becoming thinner, before the nasal notches; and, after being separated in three projecting tubercles, becomes united, by a portion which is a little thinner, to the incisive bones, where they unite, and form of themselves two other tubercles. All these four bones become so consolidated together, that the sutures by which they were connected, as well as that which distinguished the intermaxillary from the maxillary bones, are not perceptible at only a moderately advanced age. This structure, so solid, was doubtlessly intended for the support of the horn, and would lead us to suppose, that it was more strong, and could be applied with more power in this species, than in any of those which now exist. 8. Behind this junction of the nasal with the incisive bones begins a bony partition, which separates the two nostrils, and passing backwards, is united with the vomer. 9. In consequence of this partition, the incisive openings are separate from each other; whilst, in the living species, they are formed into one large opening. 10. From the length of the nasal notch, the eye is placed more backward in this than in the other species.

With respect to the existence, or the number, of incisive teeth in the fossil animal, M. Cuvier observes, that after an infinite number of researches, he has not yet obtained any thing certain: he, however, thinks he has a right to assert, that the fossil rhinoceros did not possess them, at least in the upper jaw. In the lower jaw, M. Pallas, however, speaking of a jaw found at Tchikgi, says: *In apice maxillæ inferioris, seu ipso margine, ut ita dicam, incisorio, dentes quidem nulli adsunt; verumtamen apparent vestigia obliterata quatuor, alveolorum minusculorum equidistantium, e quibus exteriores duo obsoletissimi, sed intermedii satis insignibus fossis denotati sunt. Nov. Com.* XIII. p. 600. Supposing, then, this jaw had actually contained incisors, they, from being so very small, must have belonged to a different species from any

which is known living; since the incisive teeth, in the rhinoceros of Asia and Sumatra, are considerably larger, independent of the age of the animal. Hence, if any of the fossil rhinoceroses had incisive teeth, it appears that they must have existed in the lower jaw only, and have also differed in size, and probably in form, from those of the living rhinoceroses.

It appears that two incisive teeth of the rhinoceros are in the cabinet of the celebrated anatomist Soemmereng, which, it is said, were dug out of the earth in the neighbourhood of Mentz; one of which has been figured by Merck, and another by M. Adrian Camper. Supposing, M. Cuvier observes, that these teeth are really fossil, they prove nothing contrary to what has been assumed above. This circumstance can only show, that there is also, among the fossil species, one which is different from that which has been hitherto found. The grinder teeth of the fossil species appear to agree precisely with those of the living species.

The fossil remains of the rhinoceros have been generally found in the same countries where the remains of elephants have been found: but they do not appear to have so generally excited attention; and perhaps but few of those who discovered them were able to determine to what animal they belonged. Thus a tooth of this animal is described by Grew merely as the tooth of a terrestrial animal; and the remains of this animal, found in the neighbourhood of Canterbury, were supposed to have belonged to the hippopotamus.

In Hartzberg, in the principality of Grubenhagen; Quedlimbourg, Darmstadt, the borders of the Rhine, Mentz, Strasbourg, the neighbourhood of Cologne, Westphalia, numerous parts of France, and in several parts of Great Britain, have the remains of the rhinoceros been found. In Siberia these remains have been found in considerable quantities. Pallas, whose researches have been particularly directed to this part of the world, made the astonishing discovery of a complete rhinoceros, still covered by its skin, and buried in the sand on the borders of the river Wiluji.

From several fragments of bones which I met with in the Essex bank, I was also led to suppose that the remains of some other very large animal, besides those of the elephant and elk, had been here imbedded. This supposition was increased by finding one large fragment, a complete mass of pyrites, with the form and external surface of bone, which appeared to be the upper end of an os femoris; but which, either from distortion, or from very uncommon, though natural conformation, differed from that of any animal with whose skeleton I was acquainted. This induced me to be more particular in my research, and occasioned me to discover the tooth which is represented Plate XXI. Fig. 2. This tooth, which is an upper molar tooth of the left side, is pretty much worn, and must have belonged to a small animal, since it is not one half of the size of the teeth which were found at Chartham.

My friend, Mr. Fisher, whose kindness I have already had occasion to acknowledge, was so obliging as to procure for me five teeth, which had been found at Fox-hill, in Gloucestershire, with some fragments of bones. The fragments of bones were too small to allow of any decision respecting them. One of the teeth was of the elephant; and the other four were molar teeth of the upper jaw of the rhinoceros, and had suffered a very considerable degree of decomposition. Their size was more than double that of the tooth depicted above; but their grinding surfaces had suffered very considerable injury.

The horns of the rhinoceros have been repeatedly dug up in Siberia, and of a considerable size, some exceeding in size those of the living species.

Hollman and Zuckert had fossil fragments of the humerus of this animal, from which it appeared, that the obliquity of the radial pulley-like termination, which in the living species is very considerable, is exceeded in the fossil; and, that the inferior head is longer. On comparison with the humerus of the Parisian skeleton, it appeared that the fossil humerus, though shorter, was thicker.

A scapula, apparently of this animal, found at the foot of the Hartz,

was found to have its lower edge straiter and thinner than in that of the recent animal; the projecting part, too, of the spine of the scapula, was extended much further towards the articular termination.

An atlas, figured by Hoffman, and copied by Cuvier, and which must have belonged to some animal of this genus, was compared with that of the skeleton, and found to be specifically different. A fossil axis (the second vertebra) is also figured by Hollman; and, like the former vertebra, appears, from its proportions, to be a different species from the unicorn rhinoceros. A third cervical vertebra is also figured by Hollman, corresponding with the preceding vertebræ, and, like them, differing in proportions from those of the corresponding bone in the skeleton of the unicorn.

From various comparisons of the fossil bones with those of the living species, M. Cuvier was able to conclude, that the head of the fossil species is not only absolutely much larger, but that it is also much larger in proportion to the height of the limbs, and, consequently, that the general form of the animal must have been very different from that of the living species.

A large quadruped, then, of a species unknown at the present day, is thus found buried, M. Cuvier observes, in numerous parts of Europe and Asia; and one very remarkable circumstance is, that it has not been brought from afar; and another, that it has not been by any slow and insensible change of the earth, but by some sudden change, that this species has ceased to exist. The whole rhinoceros, found with its flesh and skin, buried in the ice, on the borders of the Wiluji, evidently demonstrates, he thinks, these two propositions. How, he asks, could it have come there from the Indies, or from any other warm country, without falling to pieces? How could it have been preserved, if the ice had not involved it suddenly; and therefore, how could it have been involved in this manner, if the change of climate had been gradual and insensible?

The discovery of this animal has furnished us with some facts respecting its external structure. None of those protuberances or

irregular callosities were discoverable on the head, which render that of the unicorn-rhinoceros so hideous, but which do not exist in that of the bicorn of the Cape. It appeared also, that the hairs were very abundant on the feet, whilst none exist on these parts of the rhinoceros of the Indies or of the Cape.

The existence of the fossil remains of the hippopotamus has not been so generally admitted as those even of the rhinoceros. M. Faujas St. Fond, who is eager to establish the eastern origin of our fossil remains, is of opinion that the hippopotamus, which he believes to be an animal not known in the East Indies, has not been found among the fossil remains of animals in this part of the world. This opinion he founds, on his never having seen any of the fossil remains of this animal in the several museums he visited in England, Scotland, Holland, France, and elsewhere; and in finding no mention of them in the accounts of different travellers, or in the writings of those authors who have treated of the fossil remains of the larger quadrupeds.

In Daubenton's department of the Natural History of Buffon, it is observed by St. Fond, that a report is given of several fossil teeth of the hippopotamus, which were in the Museum of Natural History of Paris; but that, upon examination, these teeth appeared to be teeth of the mammoth, or of the animal of Simorre.

On the other hand, M. Cuvier, on examining the teeth mentioned by Daubenton, found two of them to be actually the teeth of the hippopotamus; and although he found that Lang, Romé de l'Isle, Camper, Merck, and others, had mistaken the teeth of other animals for those of the hippopotamus, he found that Antoine de Jussieu, *Mem. de l'Acad.* 1724, had undoubtedly described the fossil remains of this animal, as found in Montpellier, at a place called La Mosson. On further examination, it was clearly ascertained, that these fossils came from Languedoc, where other remains of this animal were also found, sufficiently proving the existence of the fossil remains of this animal.

From the account also of M. Fabbroni, Director of the Royal

Cabinet at Florence, it appears that there exists, in that cabinet, not only two of the molar teeth of the hippopotamus, but a fragment also of one of the tusks, or canine teeth of the lower jaw. Teeth of the hippopotamus, of different kinds, it appears, have been found scattered in several parts of the upper Vale of Arno.

Remains of the hippopotamus have been found, I am informed, in some parts of Gloucestershire. Mr. Trimmer has kindly communicated to me the information, that the remains of these animals are found in the stratum of blue clay at Brentford; and has also kindly communicated the following account of the strata, as they there occur. The first stratum is nine feet of sandy loam, or common brick earth, in which no fossils are found. 2d. Seven feet of gravelly sand, becoming so coarse, as to deserve to be called sandy gravel. At the bottom of this stratum are found the remains of hippopotami and of elephants; but they are not found in those parts to which the next stratum does not extend: to which, therefore, they may be more properly considered as belonging. 3. From one foot to nine, of an earth highly calcareous, in which are found the horns, bones, and teeth of deer, with many small shells. 4. A few feet of gravel, with water. 5. Two hundred feet of blue clay, in which are found pyritified fruits and wood, with marine fossils, particularly nautili, which are found at all depths in this stratum.

In my visits to Walton, in Essex, I have been successful in obtaining some remains of this animal. The most interesting of these specimens are—

1. An incisor tooth of the right side of the lower jaw. This tooth has lost much of its enamel, but is otherwise in good preservation, possessing all its characteristic markings. It measures fifteen inches and a half in length, and nine inches in circumference towards its base, and is of course too large to be figured in these plates.

2. The point of an inferior canine tooth or tusk, measuring full nine inches in circumference, and having seven inches in length of triturating surface. From the great size of this tooth, it is very likely to have

belonged to the same animal to which the preceding tooth belonged. Besides the longitudinal striæ and grooves observable in the enamel of its sides and inferior part, it is characterized by strong transverse rugous markings, which are placed at nearly regular distances, of about two inches; and are observed to exist in the same manner on the fragment of about eight inches in length, which joins to it.

3. A fragment of a tusk, or lower canine tooth, which is only about half the size of the preceding specimen. It has the markings of its enamel of a different character from that of the larger tooth, and particularly is devoid of those transverse rugous markings which are so strongly formed in that specimen. From the roundness of this specimen in its circumference, and from the difference of its character, I am led to suspect that it may have belonged to the small hippopotamus, which, as will be presently observed, was discovered by Cuvier, and which is only, as yet, known in a fossil state.

4. One of the anterior grinders.

5. One of the last molar teeth of the right side of the lower jaw, and which does not appear to have long pierced the gums. Plate XXI. Fig. 1.

Among the most important discoveries made by M. Cuvier, is that of a small fossil hippopotamus, of not more than half the size of the common species.

The remains of this animal were found in two pieces of sand-stone, in which the bones and teeth were disposed in a manner much resembling that which is observable in the calcareous and stalactitic masses from Gibraltar, Dalmatia, and Cette. Unfortunately, no traces existed by which it could be known where this sand-stone had been found.

After extricating, with extreme care, such bones as could be removed, and as served to demonstrate the species, M. Cuvier was gratified by finding that they belonged to an animal, the existence of which had never been imagined. This animal, it is evident, from the minute and close comparisons which were made, must have agreed, most exactly, in every character with the genus *Hippopotamus;* and

must have differed, not essentially in any respect but in its size, from that species which we know living, and whose fossil remains, we have just seen, have been also sometimes found. The size of this animal could not have exceeded half that of the ordinary species; and it is evident, from the state of its teeth, and from the advanced progress of ossification, that its inferior size could not have proceeded from its being a young animal, but from its having been of a distinct species.

In one of its large grinders, it appeared that, contrary to the horizontally worn surface of these teeth in the ordinary hippopotamus, it was worn obliquely on the anterior side, showing that its projections had shut in between the risings of the opposite tooth.

But a more important difference was observable in the lower jaw. The hippopotamus is the only known animal whose jaw, at its inferior and posterior angle, turns backward, and forms a broad hook-formed process. In this small animal, this hook-formed process not only was also observable, but it was found to be carried much further backward. In the common hippopotamus, the turn which it makes describes the fourth of a circle; but in this animal the turn forms a crescent, and is equal to half a circle.

The tapir is one of the pachydermata, and forms a genus in which there is but one species; it is an animal of South America. It is formed like a hog; and although only the height of an ass, it is the largest animal known in those parts. Its snout is elongated into a trunk, which, although not long, is moveable like that of the elephant. The fore-feet have four equal-sized toes, and the hind feet three, all of which have hoofs. It has, in each jaw, six incisive teeth, and two canine, which are not longer than the incisors. The skin is black, and almost without hairs. It is a quiet and docile animal, which lives on the banks of rivers, and feeds on reeds, sugar-canes, &c.

The tapir not having been known but in South America, it was with great pleasure that M. Cuvier ascertained the existence of the fossil remains, in France, of some animal of the same species, or very

nearly resembling it; since this must be most decided evidence against that system which attributes an Asiatic origin to our fossils.

This celebrated naturalist first noticed two specimens in the cabinet of M. de Drée, and which had been described in a Memoir by M. Dodun, being two portions of lower jaws which had been found near the last declivities of the Black Mountain, at Issel, in Languedoc, near Castelnaudari, by M. Dodun. Finding that the resemblance which these jaws bore to those of the tapir was exceedingly close, there being the same number of each sort of teeth, the same form in the molar teeth, and even the external incisive smaller than the others, as in the tapir, he was induced, at first, to declare, that the fossil jaw did not sensibly differ from the jaw of the recent animal. Subsequent examination, however, enabled him to discover, that a difference existed between the first molar teeth of the fossil and of the recent jaw. In the tapir of South America, all the molares have their crown divided into two transverse risings, of an equal width; but in the fossil animal, the three first molares, instead of transverse risings, have a kind of points or pyramids, the foremost of which is larger than that which is behind it. The anterior part of the muzzle is more narrow and long in the common tapir, than in the fossil animal. In the tapir, also, the first molar is longer than any of the four or five following ones; but in the fossil jaw this is the shortest.

These, and other less differences, induced M. Cuvier to conclude, that the fossils of the Black Mountain belonged to some species approaching to the tapir, but which was not precisely the same. These remains of an animal, the analogue of which, if living, can only exist in South America, are, in his opinion, entirely subversive of the notion of those who support the Asiatic origin of our fossils. M. Cuvier calls this animal *the small fossil tapir*.

In the *Journal de Physique* for February, 1772, there appeared the representation of a molar tooth, found in the neighbourhood of Vienna, and which appeared to have belonged to some large animal, at least resembling the tapir. Another specimen was found near St.

Lary, in Couserans. But the most interesting specimens are, the two halves of a jaw, with five molar teeth in each, in the possession of M. Drée. These fossils were found at Comminge, by the side of Beine, five leagues from Alan, a castle of the Bishop of Comminge. Similar teeth are also said, by Fabbroni, to have been found in Italy.

The teeth of the recent tapir are characterized by being divided by transverse risings; but this character, Cuvier observes, is not sufficient to allow the attributing of any fossil teeth, with transverse ridges, to the tapir; since the same transverse risings on the crown are observable in the teeth of the lamantin *(Trichecus manatus)*, and in those of the kanguroo. In the lamantin, the upper teeth have two large risings, and two smaller, or spur-like processes, one before, the other behind. On the lower teeth are three risings. These risings are, in the germ of the tooth, crenulated, both in the lamantin and in the fossil animal.

Of the five molar teeth in M. Drée's fossil, the foremost has only one ridge, which is flat; but the four last have two ridges, with a spur behind, which is largest in the hindermost teeth. The animal to which these teeth belonged, could not, as M. Cuvier observes, have been very aged, since the ridges are not much worn, and since one tooth, at least, was wanting in this jaw. This is, however, assumed on the supposition that the tooth found at Vienna, belonged to a similar animal. This tooth has three ridges and a spur-like process; and in that case, would have been placed behind these; since in herbivorous animals, the teeth composed of the most pieces are always behind the rest. The tooth found at St. Lary, and which agrees in the appearance of its enamel and matrix, with those of M. Drée, has also three ridges, which confirms the opinion of this animal having six molar teeth on each side. Reckoning from the size of the molar teeth of the fossil animal, it is supposed that it must have been one-fourth taller than the rhinoceros. But, by the same made of reckoning, it would have been five times longer than the known lamantin, and eight times larger than the kanguroo, supposing it to have had the same proportions as the species to which it may be imagined to belong.

These fossil remains M. Cuvier considers as belonging to a large animal, which might have approximated to the tapir, and which he calls the *large fossil tapir*. Plate XXI. Fig. 3, is the outline of the fossil tooth of this gigantic animal, found at St. Lary, in Couserans, copied from M. Cuvier's engraving, Pl. II. Fig. 7, *Ann. du Mus.* Tome III.

LETTER XXIX.

FOSSIL PACHYDERMATA OF THE ENVIRONS OF PARIS....PALÆOTHERIUM MAGNUM, MEDIUM, CRASSUM, MINUS....ANOPLOTHERIUM COMMUNE, MEDIUM, MINUS, MINIMUM....UNDETERMINED ANIMAL OF ORLEANS.

I SHALL, with great pleasure, show you in the present Letter, that the unceasing and ingeniously directed labours of Cuvier have been rewarded by the discovery of the fossil remains of two genera of pachydermata, containing seven or eight different species, the analogues of which are at present entirely unknown. To one of these he has given the name of ***Palæotherium***, or ancient large animal or beast; and to the other, ***Anoplotherium***, or beast without weapons, thereby implying its distinguishing character, its want of canine teeth.

Much of this information was yielded him by the teeth alone; but, in addition to these, he became possessed of other different bones of these animals, and particularly of the bones of the feet, by which the conjectures which he had already formed, respecting the nature of these animals, obtained a considerable degree of confirmation: but as he had found the heads belonging to two genera, one with and the other without canine teeth; so he also found the feet of two genera, one with three complete toes, and the other with two.

The bones of the feet of one kind required to be classed with the heads of one of these genera, and the bones of the feet of the other kind with the head of the other genus. But how was this separation to be effected? Did the feet with three toes belong to the head with tusks, and those with two toes to the heads without tusks, or should they be disposed in a contrary combination?

After much perplexing investigation, he derived considerable aid by meeting with a head without tusks, not larger than that of a hare, and fortunately with a didactyle foot of the same proportions. Thus assisted, he proceeded in his comparisons, and was at last able to determine that the *didactyle* feet belonged to the *Anoplotherium*, and the *tridactyle* to the *Palæotherium*.

M. Cuvier observes, that the first information to be obtained, in the examination of the remains of a fossil animal, is with respect to its grinding teeth. By these may be ascertained whether the animal was carnivorous or herbivorous; and if the latter, the order of herbivorous animals to which it belonged, may, even, thereby, be determined, to a certain extent.

A superficial examination soon showed him, that almost all the animals found in the plaster-of-paris quarries, round Paris, have the grinders of the herbivorous pachydermata; those of the upper jaw possessing a crown formed of two or three simple crescents, succeeding to each other; a configuration which may be seen to exist in the rhinoceros and the daman, *Hyrax*, Linn. two genera of the pachydermata. The ruminating animals, indeed, have also grinders composed of two or three crescents; but their crescents are double, and have each four lines of enamel; whilst in the pachydermata they are simple, and have only two lines. These remarks were confirmed by the appearances yielded, in these fossils, by the upper grinders; their outer face having three projecting ribs, which divide it into two shallow depressions; their crowns are square, and have peculiar inequalities. These characters serve to remove, decidedly, these fossil animals from

the family of ruminants, and to approximate them to the daman and rhinoceros.

The teeth found in the plaster-of-paris are of different sizes, but those of the middling size occur most frequently. These, M. Cuvier has demonstrated, belonged to two different genera, one of which possessed canine teeth, and the other, not. A careful examination showed also, that the grinders of these different animals, although seemingly similar, possessed decidedly different characters.

Commencing his inquiries with the genus PALÆOTHERIUM, the large ancient animal, with canine teeth, he was enabled to ascertain that, as in the rhinoceros and daman, so in this genus, there are seven grinders in each side of the lower jaw, the first of which is small, compressed, and rather sharp. The others have their outer surface formed like two portions of cylinders, except the seventh, which has three of these portions. At the base is a projecting line like a collar, beneath which is a root to every portion.

The internal surface of these teeth is, in some respects, the reverse of the inner surface. Opposite to each of the crescents is a depression, which narrows as it descends: the intervening projections, of course, narrowing as they ascend.

Before the first small grinder, the jaw is void of teeth, or alveoli, for a little space, at the end of which space is the canine tooth. It is a simple oblique cone, a little bent; the internal face of which is a little flat, and its external face more than half a cone. Its faces are separated by two longitudinal ridges, and its bases are girted by the same collar-like projection as was observed in the molar teeth. The root is large, and penetrates into the jaw nearly as far as the root of the first grinder.

This canine tooth is not a tusk projecting out of the mouth, as in many species of hogs: it is rather concealed by the lips, as in the tapir, hippopotamus, and Mexican hog. By the presence of this tooth, this animal is separated from the rhinoceros and daman, whilst, by its grinders, it is brought near to the tapir and hog.

The incisive teeth are of the common wedge-like form, and are six in number, which is the exact number of those of the tapir, with which they also very nearly agree in their forms.

In the fossil specimens of the upper jaw are also the corresponding number of six incisors; behind which is the upper canine tooth, which does not project any more than that of the tapir or pecari. Behind this tooth is a small space for the reception of the point of the canine tooth of the lower jaw.

The upper grinders have their crown nearly square, and have four roots, whilst those of the lower have but two: the foremost only are a little narrower in proportion than the others.

The outer face inclines obliquely inwards as it descends, and is divided by three longitudinal ridges, into two concavities, rounded towards the root, and terminating in a point towards the grinding surface. By the angles thus formed, a line results at the outer edge of the grinding surface, in the shape of a W; and from the inclination and the concavities on the external surface results another line in the form of a W, in the horizontal direction. In these teeth, then, are the same squareness of form, the longitudinal ribs on the external face, and the same line in the shape of a W, as in the upper grinders of the rhinoceros; but the distribution of the risings and depressions on the grinding surface, and of the enamel, is essentially different.

Plate XXI. Fig. 4, represents the outer surface of the fourth molar tooth of the lower jaw of *P. medium;* and Fig. 5, represents its inner surface. Fig. 6 is the outer surface; and Fig. 7 is the inner surface of one of the molares of the upper jaw of the same animal.

Thus Cuvier has been able to determine, that in the gypsum there exist the remains of an animal which had twenty-eight grinding teeth, twelve incisive, and four canine. The lower grinders formed in two or three simple crescents, and the upper square, with many markings on their crown: the canine teeth not passing out of the mouth. It appears also that this animal must, from the number of its teeth, have

been of a genus near to that of tapir, and to that of rhinoceros, by the form of its grinders. That it was an herbivorous animal is certain; and that it belonged to the order of pachydermata is confirmed, as will be seen, by the structure of its feet.

The glenoid cavity, for the articulation of the jaw, had a flat surface, as in that of the tapir; and as, in the tapir, this cavity was bounded backward by a transverse vertical plate:—a peculiarity, however, exists, with respect to this plate; for that of the tapir has its internal edge more forward, and the external more backward; whilst in this animal it is exactly contrary.

In the horse this plate is very short, and is from right to left. In the ruminating animals it is more projecting and entirely transverse; or, as in the tapir, more drawn back to the outer edge. It makes less projection in the hog: that of the rhinoceros is not behind, but at the inner edge of the glenoid cavity; and the elephant has none. It appears that no known animal has the glenoid cavity formed like that of the *palæotherium.*

By the most ingenious inferences from the form and the number of bones constituting the nostrils, and from other characters, he was led to conclude that this animal possessed a kind of snout, or trunk, resembling that of the tapir. Judging of the size of the first animal of this genus, whose remains he discovered, he concluded that it must have been less than the tapir, and nearly as large as a common hog; and directed by the proportions which its remains bore to those of other species, which he afterwards met with, he designated this species as *Palæotherium medium.*

From an astragalus, and from several other bones remarkable for their thickness, he decidedly made out the existence of another species, rather less than the *P. medium,* but which he conceived it right to name *P. crassum.*

By his investigations, M. Cuvier discovered the fossil remains of another animal, differing in no respect but in being more than double its size, from the *P. medium.* This animal, which he supposes must have

been of the size of a common cow or of a small horse, he considered as being of a different species, and named it ***Palæotherium magnum.***

He found also several fragments, which enabled him to determine that these quarries contained also the remains of another animal of this genus, but which could not be larger than a fox, to which he gave the name of ***Palæotherium minus.***

It appears, therefore, that he discovered, and decidedly made out, four species of this genus :—***P. magnum***, ***P. medium***, ***P. crassum***, and ***P. minus.***

Proceeding in his inquiries, M. Cuvier obtained a very interesting specimen from the gypsum quarries, containing two bones of the metacarpus (those of the index and medius) nearly entire ; an impression of that of the next, annulare; and four bones of the carpus, semilunare, unciforme, the analogue of os magnum, here very small, and trapezoide.

At first sight these bones appeared, in their general arrangement, as well as in their particular configuration, very much to resemble their analogues in the tapir. By the acuteness, however, of M. Cuvier, sufficient differences were discovered in their forms, to determine that they did not belong to that animal. He discovered that, in those few points in which they differed from the analogous bones of the tapir, they seemed to resemble those of the rhinoceros. On considering that the teeth of the *palæotherium,* in like manner, seemed to partake of the nature of each of those animals, but to approach nearest to that of the former, M. Cuvier observes—" One must be stricken with increased admiration at the unalterable constancy in the natural agreements of animals, even in the minutest details." From this correspondence he was able determine that these remains must have belonged to some animal of the genus *palæotherium ;* and, from their size and proportions, to that species to which the designation *medium* appeared to belong. In another specimen he found some metacarpal remains, which, on account of their shortness and thickness, he had no doubt of their belonging to that species which he had named *P. crassum.*

Another specimen of the fore-foot of *P. medium*, formed of three entire fingers, the vestige of a thumb, and of a little finger, came under the observation of M. Cuvier. He also obtained carpal remains, which, from their size and proportions, he was confident in attributing to *P. magnum* and *minus*.

In the plaster-of-paris, bones of the upper extremities were also found, which were divisible by the species of articulation employed in the elbow, into those of two distinct genera. In one set of the radii, the upper head was divided in the middle by a ridge, on each side of which was a depression ; and, in the other set, there were three depressions, separated by two blunt ridges.

The former of these, those with two depressions, were ascertained to belong to the genus *Palæotherium*. Ossa humeri were also found, corresponding in their lower head with these radii, and consequently having two prominences corresponding with the depressions in the head of the radius. The ulna of this genus appeared to resemble very much that of the tapir : some differences were, however, observable, but these were but slight.

To obtain the information which M. Cuvier possesses, respecting the scapulæ of the animals of this, and of those of the succeeding genus, must have required, as he justly observes, prodigies of patience, in those who separated the parts of these tender and fragile bones, from the stone in which they were imbedded. In consequence of these successful exertions, he was enabled to ascertain, that these bones were all referable to two general forms. In the one kind there existed no acromion, the spine raising itself gradually unto about two thirds of its length, where is its most projecting part, and where its edge is most widened, and blending itself forwards with the outer face of the scapula. The scapula of this description appears to have belonged to this genus : the other kind of scapula, which appears to have belonged to the genus *Anoplotherium*, will be noticed in its place.

The existence of three toes on the hind feet of this genus, is proved

by a foot, which was found nearly entire, with three metatarsal bones and a supernumerary bone, and which appeared to belong to *P. medium.*

Although the structure of this foot does not so materially differ from those of the animals of the present day as that of the *Anoplotherium* does, it approaching somewhat to the tapir, it is still undoubtedly of a structure at present unknown. That the hind foot of the animal, considered as *P. magnum,* was tridactyle, was evinced by the form of a fossil astragalus of this animal. The foot which appeared to belong to the species *P. minus* agreed with the preceding in having three metatarsal bones, and a supernumerary bone, but was not larger than that of a fox.

Besides those bones of the hind feet which are referable to the preceding species, a tridactyle foot was found, rather less than that of a hog, and shorter and thicker than that which is attribted to the *P. medium,* and was therefore considered as belonging to *P. crassum.*

An astragalus was found which materially differed from that of known animals. It approached the nearest to that of the tapir; but it differed from it obviously in several points, and from its thickness was supposed to belong to the last-mentioned species.

The quarries of Paris also supplied M. Cuvier with the tibia of *P. medium.* He also obtained the tibiæ of *P. magnum, P. minus,* and *P. crassum;* and was able to determine, that in these animals, and in those of the genus *Anoplotherium,* the fibula was complete and distinct, as well as in the other pachydermata.

We have seen that the teeth, as well as the feet, point out an analogy between this animal and the rhinoceros and tapir, and M. Cuvier has been able to show an equal correspondence in the os femoris. Three species of quadrupeds, the rhinoceros, tapir, and the solipedes, are distinguished from the others by a third trochanter, or a strong apophysis on the outer edge of the bone, below that which is known as the great trochanter. In the fossil os femoris, this third trochanter is rounded and blunt; but made a little hooked forwards, and is placed

a little lower, on the outer edge, than the small trochanter is on the inner. Other characters observable in this bone correspond with some which exist in that of the ass and of the tapir, but mostly with those of the former. He was, however, enabled to determine that this os femoris did not belong to either of these animals; but was satisfied that it belonged to one of the species of the genus *Palæotherium;* and, from its size, to *P. medium* or *P. crassum.*

The specimens of the remains of the *Palæotherium* are too incomplete to have supplied their learned and indefatigable investigator with much satisfactory information with respect to its vertebral column. From detached points of information, M. Cuvier has, however, been able to determine, that the palæotherium had its neck longer in proportion than the hog and the tapir, and that it approached those ruminants with a neck of a moderate size, and with a slight form, such as the stags and antelopes; such, at least, appears to have been the case with *P. minus.* From a portion of a tail, composed of five vertebræ, and which seems to have belonged to *P. medium*, it appears that the tail in these animals was not so long in proportion as in the *Anoplotheria.*

The skeleton of the *Anoplotherium* points out twelve or thirteen as the number of ribs belonging to this genus, and those of the *Palæotherium* sixteen: two numbers which suit well with the zoological affinities of the two genera; since the first agrees with that of the ruminants and pigs, which have thirteen or fourteen, whilst the other suits with the tapir, rhinoceros, and horse, which have eighteen and nineteen.

At Pantin a specimen was found, containing great part of the skeleton of an animal, which was supposed by the workmen, and reported by the public papers, to have been that of a ram; but when it was seen by Cuvier, on its being presented to the Museum, he discovered that it was of the *Palæotherium minus.* This skeleton considerably confirmed the conjectures which he had already formed respecting the fossil remains of this genus.

In this skeleton he discovered sufficient of the lower jaw to observe the peculiarities of its character. There existed six cervical vertebræ, the atlas only being wanting. Little of the scapula remained; its impression was, however, to be seen. The humerus was nearly entire, and the fore-arm was composed of a separate radius and ulna, showing that this animal differed in this respect from the ruminating animals. From these remains it appeared, that this animal must have had at least sixteen, or perhaps, seventeen ribs, on each side; a circumstance confirmatory of the opinion of this animal having been one of the pachydermata: but as the sternum was not discoverable, it could not be determined how many ribs had been attached to it. The dorsal vertebræ were mostly removed, nor could the number of the lumbar vertebræ be ascertained. The sacral and coccygæal vertebræ, with the pelvis, were lost. The femur was very imperfect; but it could be determined, that the tibia and fibula were distinct, as in the pachydermata.

In at least four distant parts of France, at Paris, Montabusard, Buchsweiler, and Issel, the remains have been found of animals of the genus of *Palæotherium;* some of which differed, in some respects, from those which have been already described. One of these animals, calculating from an astragalus found at Montabusard, appears to have been larger than even that which has been described as *Palæotherium magnum.* It appears to have been larger than that of the largest horse, and only about an eighth less than that of the rhinoceros. It is calculated to have been eight feet long, without its tail, and about five feet high at the withers.

From some fragments of jaws obtained from the neighbourhood of Orleans, it was ascertained that those quarries contained the remains of an animal rather smaller than the *P. medium*, the teeth of which more resembled those of the rhinoceros, and still more those of the daman, than of the *palæotherium.* On the meeting of the two arcs or crescents, at the middle point of the W, the point was double, instead of being single, as in the *palæotherium.* From this, and other

differences, and not having been able to obtain the incisors and canine teeth adherent to the jaw with a grinder, M. Cuvier hesitates at determining this tooth to belong to an animal of this genus.

With these teeth, which are rather smaller than those of *Palæotherium medium*, two fragments of os humeri, very closely corresponding, as to size, were also found.

The remains of another species, approaching to the *palæotherium*, was found by the Professor Herman, of Strasbourg, in the department of the Lower Rhine, in the mountain of St. Sebastian, one of the lowest in the chain of Vosges, in a calcareous bed mixed with fresh-water shells, and what is very remarkable, covered, as in the beds of gypsum which contain the *palæotherium* in the neighbourhood of Paris, with several beds full of marine productions. This animal, like the *palæotherium*, had both canine and incisive teeth, but it had one molar tooth less, and had not the space which in the *palæotherium* exists between the first molar and the canine tooth. The other observable specific characters of the lower as well as of the upper jaw, leave no doubt that the animal to which these teeth belonged nearly approached to the *palæotherium*.

Having placed before you a sketch of the interesting discoveries respecting the genus *Palæotherium*, I shall proceed to give you a slight view of the discoveries respecting those animals whose remains were found with these, but which did not possess canine teeth: to the genus comprising which was given the name *Anoplotherium*.

It has been already remarked, that among the teeth which Cuvier had discovered, some of the grinders appeared to belong to an animal which had no canine teeth. These grinders, which were thought to somewhat resemble those of the *Palæotherium*, are found to differ from them in the following respects. The outer surface of the lower grinders has not cylindrical, but conical convexities, narrowing very much upwards. These convex portions are three in number in the last grinder, and two in the two next. Towards their base, their curve becomes double; that is to say, that they are convex, not only

transversely, but in every direction; and their base is without any collar-like projection. These remarks are chiefly applicable to the three last grinders: the others are different in every respect.

The last of these, that which precedes the antepenultimate, has three slight convexities on its external face, and three points on its crown, which render the coronal line undulating. From this line, near its middle, a branch is given, which passes towards the internal face, and there bifurcates. The next two have also three convexities and three points, but their crowns have not the branching line; or if a little of it exists in the second of these teeth, it does not bifurcate. Before these stands the one which answers to the first of the *palæotherium*. It is equally simple with that, and is compressed, and generally pointed.

In this part, in the *palæotherium*, commences the vacant space, at the end of which is placed the canine tooth. Neither of these existed in this animal; but, immediately before the small molar tooth last described there are three incisors, nearly similar to the preceding tooth, but which become more and more pointed. Hence there appears to have been, in the lower jaw of this animal, fourteen grinding and six incisive teeth, without any canine tooth or intervening space.

For the purpose of showing the difference of form between the two kinds of grinders in this animal, one of each is here figured Plate XXI. Fig. 8, being the antepenultimate; and Fig. 9, the one before the antepenultimate; or, in other words, Fig. 8 is the first of the last three grinders; and Fig. 9, being the next to it, is the last of the other series.

The propriety of necessity, indeed, of regarding this animal, as distinct from any known genus, will appear from these considerations. Among the pachydermata, the rhinoceros and daman alone are without canine teeth; but they have but four inferior incisors, or they even want them entirely; and when they do possess them, there always is an interval between the last incisive and the first grinder.

Nothing similar can be expected to be found out of the class of

pachydermata: the gnawers *(rosores)*, the ruminants, the solipeds, all have the intervening space. The ordinary carnivorous animals, and the quadrumanes, have all large canine teeth. There are only the hedgehog and the shrew which manifest any analogy with this animal, with respect to their teeth. But their lateral incisors are so obliquely sharp, and their canine or first molar teeth are so like incisive, that, without speaking of the enormous difference of size, the number of their grinders, and the form of the jaws, are quite different. It cannot, however, be denied, that there exists some resemblance in the shape of the grinders themselves.

In the lower jaw of this animal, the great width of its rising branch, and that convexity of its posterior edge, which is hardly ever seen but in the daman and tapir, are observable. The coronoid process is large and hooked, and rises very considerably above the condyle.

The teeth of the upper jaw appear to correspond with those of the lower jaw: there not being any canine tooth, nor any space between the incisive and the grinders. The greatest correspondence between the teeth of this animal and those of the *palæotherium*, is to be found in the three last grinders, whilst the others essentially differ.

The size of the most common species of this animal, he conjectures to have rather exceeded that of the wild boar. Besides the remains of this species, he found those which were evidently of a smaller species, about the size of a small sheep, which he named *A. medium*. He discovered the remains also of a still smaller species, in which the hinder part of the jaw, and particularly the coronoid apophysis, appeared to differ from that of the former species. This species, which seems to be very rare, he distinguishes as *A. minus*. The examination of some remains of another animal, which must have been about the size of a rabbit, led him to suspect, but did not allow him to determine, that there had existed a smaller species, to which he would have given the name of *A. minimus*.

Having determined the existence of three or four species in this genus,

M. Cuvier proceeded, with patient assiduity, to trace out the remains of the other parts of these animals, and his researches were amply repaid. The structure of the hind-leg was the first object of inquiry.

Besides other minute peculiarities in the form of each particular bone, dependent on the general structure of the limb, he found that *Anoplotherium commune* had, to the hind-leg, two perfect toes articulated with two metatarsal bones, which remained distinct and separate through life. This species of structure is unknown among living animals; since the ruminating animals, and even the camel, which agrees with this animal, in having a separation of the scaphoid and cuboid bones, have their metatarsal bones united through their whole length, in one piece, forming the cannon-bone, and in which, however, its double origin is not concealed.

The structure of the hind-foot alone, therefore, would have been sufficient, if we had been ignorant of the peculiarities of the head, to have shown, that this animal was of a species at present unknown. From the structure of this part it may also be seen that this animal agreed in one respect with the pachydermata, and in another with the ruminants, with which it is connected by the medium of the camel.

From the thickness and shortness of these bones, considered as to their length, this animal may be concluded to have been very large proportioned to its height—a conclusion which will be found to be warranted by the proportions of the bones of its legs and thighs.

The investigation respecting the hind feet of *Anoplotherium medium*, was still more satisfactory than even that respecting *A. commune;* since a left foot, forked, and having two distinct metatarsal bones, was found almost entire, but much smaller and thinner than that already described. This foot was of a size which would have agreed with that of a sheep of a middling size; and though belonging to the same genus, appeared to warrant the conclusion, that the animal must have been taller and thinner, in proportion, than the preceding species.

Anoplotherium minus appeared, from an astragalus, which certainly

belonged to it, to be about the size of a hare, and to have agreed in its structure with the feet of the preceding species.

No remains of the hind-feet of *Anoplotherium minimum* were met with.

A thigh-bone is frequently found in the plaster quarries, which differs from that of *palæotherium*. Its upper part is flatter forwards, the neck is less distinct, the great trochanter is not raised above the head, the small trochanter is compressed, and placed entirely on the inner edge of the bone, beneath the head; and it has no third trochanter. The general characters of this bone were found to agree better with the corresponding bone in the camel, than with that of any other animal; agreeing, in this respect, with the large fossil didactyle foot above-mentioned. From the agreement also of that foot with this thigh-bone in size, he concludes that both may have belonged to the same animal, which he doubts not was *Anoplotherium commune*.

From the same quarries was also obtained the lower head of an os femoris, undoubtedly of *Anoplotherium medium*, but resembling very much that of the antelope; and, from other characters of the legs of this animal, there is also reason to suppose that it possessed all the lightness of the antelope.

These quarries also supplied him with the tibiæ of *A. magnum*, *A. commune*, and *A. minus*. Besides these, M. Cuvier found a tibia, which appeared to be intermediate between that of the *A. commune* and *A. medium*, the species of which is not yet determined.

These animals, as well as the *palæotheria*, had a complete and distinct fibula, in which they agree with the whole of the class of pachydermata: but, in these animals, this bone is distinguishable by its lower head having two articular faces; one for the astragalus, and the other for the os calcis.

Three carpal, and some metacarpal bones, which were found in different stones, appeared to be more or less analogous with those of a hog. A nice and careful comparison, however, made it appear

that these bones possessed an intermediate place between those of the hog and some of the other pachydermata on one side, and those of the ruminating animals on the other. On referring to the hind-foot of *Anoplotherium commune*, which he found to occupy a similar place between the pachydermata and ruminating animals, he was led to conclude that this fore-foot belonged to the same animal ; a conjecture in which he was completely confirmed, by the examination of another specimen. From the examination of other fragments, he had also the satisfaction of making out, that the bones of which they were composed had formed the fore-foot of *Anoplotherium minus*.

He thus obtained the parts of at least three fore-feet, answering to the three hind-feet, and to the sorts of jaws before described. He was not so successful as to *Anoplotherium minimum ;* he, however, found sufficient reason for exultation, at having been able to carry his discoveries thus far, considering the difficulty of such investigations. The reader, he observes, may form an idea of it, when he learns, that it required six years to collect and combine the materials of the inquiry respecting the fore-feet of this genus.

In the former part of this letter, you will have observed that two distinct sets of bones of the upper extremities were found, in one set of which the radius had two depressions, and the lower head of the humerus two corresponding eminences, and in the other the radius had three depressions, and the corresponding surface of the humerus three eminences. The former of these were determined to belong to the genus *Palæotherium ;* and a very careful investigation determined, that the latter set belonged to the genus *Anoplotherium.* No specimens of the ulna were found sufficiently perfect to allow of any satisfactory comparisons.

The scapula, mentioned in the former part of this letter as belonging to the animals of this genus, possessed an acromion ; the spine projecting more in the fore part than in the rest of its length, gives out an isolated production, which is also directed forwards. A curious

agreement here offers itself to our observation. The pachydermata and the solipeds have no trace of an acromion; and in the ruminants, although the spine projects most in its fore part, it is there suddenly truncated. It is only in the genus *Camel* that an exception has been found, the fore and outer angle of the spine being here prolonged into a true acromion; and which is, indeed, more strongly marked in the lama than in the camel and dromedary. This agreement with the camel in this respect, corresponding with those resemblances which have been noticed in several other bones of this genus, assist in determining this scapula to belong to the genus *Anoplotherium.*

Fragments of a pelvis obtained from this quarry, and which resembled, in different points, that of the camel and of the tapir, are referred by M. Cuvier to this genus.

Eight years were passed in the examination of different specimens from the Paris quarries, in which M. Cuvier obtained only separate bones, and in which he had not obtained any specimen which would positively confirm the disposition he had made of the two sets of feet with the two sets of jaws. At last, he was so fortunate as to obtain two skeletons, almost complete, of *Anoplotherium commune*, which confirmed, beyond conjecture, the arrangements which he had before made, of the detached bones, and which have been here adopted.

The first was contained in several large stones from the quarry of Montmartre, and appeared to have been the entire skeleton of an animal of the size of a small horse. The parts which M. Cuvier obtained were, a portion of the tail, the pelvis, ribs, two thirds of the os femoris, and some scattered bones of the hind-foot, with the two jaws. One side only of the skeleton was preserved, as is the case with all those of the large animals in these quarries; being that, M. Cuvier supposes, on which the animal lay, the upper side being detached and removed before it became incrusted with the stone. It appears also, that in this interval, the fore extremity and a part of the hinder of the remaining side had been carried away, perhaps by some voracious animals,

it being very plain, that the lower part of the os femoris had been carried away before it had been incrusted.

In complete confirmation of the propriety of the previous arrangement which had been made of the separate bones, this specimen showed that the number of ribs was twelve, again pointing out that analogy with the camel which had been already seen in several of the other bones. But the most novel, and at the same time the most unexpected character, demonstrated by this specimen, was, the vast magnitude of the tail, which had at least twenty-two vertebræ, and which equalled, if it did not even surpass, the body in length. From the thickness of its vertebræ, and the projection of their apophyses, it is evident that the muscles of the tail must also have been of considerable size; and, indeed, the traces left on the stone give reason for concluding that the thickness of the tail of this animal must have been as enormous as its length.

Soon after making the necessary remarks on the preceding specimen, M. Cuvier obtained part of a second skeleton of the same animal, found in the quarries of Antony. The quarries of this part are nearly a hundred feet under ground, and descend at least fifty or sixty feet under the river de Bievre. The principal mass of gypsum, which occupies the bottom of the quarry, is about eight feet thick, and is covered by a great number of beds of different kinds of marl, intermixed with some small beds of gypsum, in one of which this skeleton was found.

From this skeleton, also, much important information was obtained respecting this animal; particularly, that the number of incisive teeth is six: the lumbar vertebræ also six; the transverse processes of which, particularly of the four last, being extremely long and wide: the sacral vertebræ three, all very strong, and provided with very large apophyses, such as would have been necessary for supporting the enormous tail of this animal. The fore-foot was also found almost whole, and possessed precisely the characters which had been supposed, from a view of the separate bones.

When the complicated form of a vertebra, with its various cavities and projections, is attended to, it must be plainly seen, that few of these bones, when found, can be extricated from their stony matrix, but with so much injury, as can hardly fail to destroy those parts, the examination of which is necessary to the determination of their characters. The skeletons already noticed, and particularly the two skeletons of the *Anoplotherium*, furnished M. Cuvier with that information, however, which rendered his subsequent examination of the separate vertebra more satisfactory than it would otherwise have been.

There appears to be no room, for doubting, that in the *Anoplotherium commune*, there were seven vertebræ in the neck, twelve or thirteen in the back, six in the loins, three in the sacrum, and twenty-two in the tail. The number of those in the trunk agree with the greatest part of the ruminants ; but those of the tail are much more numerous than are in general seen in this tribe : the kanguroo approaches the nearest in this respect, but it has only nineteen.

In the lumbar vertebræ of this animal, the anterior articular apophyses are hooked, by which they embrace the posterior apophyses of the preceding vertebræ ; a species of structure which exists, more or less, in the ruminants and in the hog, but not in the horse or tapir. A curiously formed inferior spinous apophysis is observable on some of these vertebræ ; respecting the use of which, M. Cuvier hesitatingly queries—" Were the inferior muscles of the great tail, which characterize this animal, inserted there ?" The angular bones were of considerable size in this extraordinary animal, showing that the muscles of the tail were exceedingly powerful.

In addition to these animals, he obtained from these quarries half the jaw of a small carnivorous animal, and was much surprised at finding that, of the genus *Canis*, to which it appeared to belong, not the jaw of any species agreed with it. It appears, therefore, probable, that this carnivorous animal, like the herbivorous we have been describing, is of a species at present unknown. This would be certain,

if the skeletons of some species, such as the *Isatis, chacal du Cap*, had been examined. An astragalus was also found of some carnivorous animal, and which was a third smaller than it should be, to accord with the jaw just mentioned. Remains of tortoises, lacertæ, and of other animals, have also been found in these quarries.

It is a most important remark of M. Cuvier, that in a country so extensive as that in which the quarries exist, and which reach more than twenty leagues from East to West, hardly any bones have been found but of one family, the pachydermata; and that the small number of species not of this family should be there so extremely rare.

Looking at the actual state of the globe, we find, as M. Cuvier observes, that the countries which constitute the two great continents, taking, for example, the different countries of Europe and America, are inhabited by all the families of quadrupeds, according to the latitude and the nature of the soil, &c.

But it is not so in the large islands; and New Holland, in particular, may, by its actual state, teach us what may have been the state of the country which was inhabited by the fossil animals of these quarries. Five-sixths of the quadrupeds of New Holland belong to one family only, *Pedimanes*, or marsupial quadrupeds. This extensive, but insulated region, shows us therefore, in the proportion of the several families of quadrupeds which inhabit it, something very similar to what existed formerly in the countries which were inhabited by the animals of these quarries. In New Holland, besides the marsupial animals, a wild dog, two species of rats, and some bats only, have been found; and in these quarries one carnivorous animal only has been found, and eight pachydermata.

The following recapitulation, by M. Cuvier, of the history of fossil bones of pachydermata, found in alluvial soil, is, I conceive, sufficiently interesting, to authorize my placing it before you without abridgment.

"The loose soil which fills the bottom of valleys, and which covers

the surface of large plains, has furnished us, in the order of *Pachydermata*, with the bones of eleven species: a *rhinoceros*, two *hippopotamuses*, two *tapirs*, an *elephant*, and five *mastodons*.

"All these eleven species are at the present day absolutely strangers to the climates in which their bones are thus found.

"The five *mastodons* only can be considered as forming a genus distinct and unknown, but near to that of the *elephant*.

"All the others belong to genera at present still existing in the torrid zone. Three of these genera are only found in the ancient continent: the *rhinoceros*, the *hippopotamus*, and the *elephant*: the genus *tapir* exists only in the new.

"These species, belonging to known genera, sensibly differ, nevertheless, from the known species, and ought to be considered as particular species, and not as mere varieties.

"This cannot be liable to the least contest, as to the *small hippopotamus* and the gigantic *tapir*.

"It is also very certain, as to the fossil *rhinoceros*. As to the *elephant* and fossil *tapir*, it is less evident; there are, however, more than sufficient reasons to convince the experienced anatomist.

"Lastly, the *large hippopotomus* is the only one of the eleven fossil quadrupeds, of which there are not pieces sufficient to enable us to say positively whether it differs or not from that which now exists.

"Of the eleven species, one only, the great mastodon (mammoth) had been known before my labours, as a lost animal: two others, the *rhinoceros* and *elephant*, had been well ascertained as to their genera; but I am the first who gave, with exactness, their specific differences: seven, the *small hippopotamus*, the two *tapirs*, and the four smallest-sized *mastodons*, were entirely unknown before my researches: lastly, the eleventh, the *great hippopotamus*, which remains as yet the subject of some doubts."

When you add to these the eight pachydermata found by this accurate investigator in the gypsum quarries, you will doubtlessly rejoice

with me, that such industry and well-applied perseverance should have been rewarded with so much success.

From these facts he deduces the following inferences.

"These different bones are buried almost every where, in nearly similar beds: they are often blended with some other animals resembling those of the present day.

"These beds are generally loose, either sandy or marly; and always neighbouring, more or less, to the surface.

"It is then probable, that these bones have been enveloped by the last, or by one of the last catastrophes of this globe.

"In a great number of places they are accompanied by the accumulated remains of marine animals; but in some places, which are less numerous, there are none of these remains: sometimes the sand or marl, which covers them, contains only fresh-water shells.

"No well authenticated account proves that they have been covered by regular beds of stone, filled with sea shells; and, consequently, that the sea has remained on them, undisturbed, for a long period.

"The catastrophe which covered them was, therefore, a great, but transient inundation of the sea.

"This inundation did not rise above the high mountains; for we find no analogous deposits covering the bones, nor are the bones themselves there met with, not even in the high vallies, unless in some in the warmer parts of America.

"These bones are neither rolled nor joined in a skeleton, but scattered, and in part fractured. They have not then been brought from afar by inundation, but found by it in the places where it has covered them, as might be expected, if the animals to which they belonged had dwelt in these places, and had there successively died.

"Before this catastrophe, these animals lived, therefore, in the climates in which we now dig up their bones: it was this catastrophe which destroyed them there; and, as we no longer find them, it is evident that it has annihilated those species. The northern parts of

the globe, therefore, nourished formerly species belonging to the genus *elephant*, *hippopotamus*, *rhinoceros*, and *tapir*, as well as to *mastodon*, genera of which the four first have no longer any species existing, except in the torrid zone; and of the last, none in any part."

Nevertheless, there is nothing to authorize the belief, that the species of the torrid zone have descended from the ancient animals of the North, which have been gradually or suddenly transported towards the equator. They are not the same; and we may see, by the examination of the most ancient mummies, that no established fact authorizes the belief of changes so great as those which must be assumed for such a transformation, especially in wild animals.

Nor is there any strict proof that the temperature of the northern climates have changed since this epoch. The fossil species do not differ less from the living, than certain northern animals differ from their co-genera of the south: the *isatis* of Siberia, for example *(canis lagopus)*, from the *chacal* of India and of Africa *(canis aureus)*. They therefore ought to have belonged to much colder climates.

LETTER XXX.

FOSSIL REMAINS OF ANIMALS OF THE ORDER BRUTA, OF LINNÆUS; TARDIGRADI, OF DUMERIL.......MEGATHERIUM........MEGALONIX.

The sloths, of which there are but two species, the Aï, *Bradypus tridactylus;* and the Unau, *Bradypus didactylus;* form the only genus which M. Dumeril has placed in the family of *Tardigradi.* Linnæus has disposed these animals under the genus *Bradypus*, in the order *Bruta*. The fossil remains which are here to be noticed will be found to approximate not only to these animals, but also to the ant-eaters, the next genus, *Myrmecophaga*, in the order *Bruta*, of Linnæus; and the first in the family of *Edentuli*, of *Dumeril.*

The osteology of the sloth is particularly interesting, not merely from the explanation it affords of the singular circumstances resulting from the economy of these animals, but also from the information which it enables us to obtain respecting the nature of the *Megatherium* of Paraguay, and of the *Megalonix* of Virginia. Influenced by these considerations, Cuvier availed himself of the opportunities of examination which he possessed, and published an account of the observations which he had thus made. *Ann. du Mus.* Tome v. p. 189.

Of the sloths, he observes: We find in them so little agreement with ordinary animals—the general laws of organized bodies at present existing apply so little to them—the different parts of their bodies seem to be so much in contradiction to the rules of co-existence

which we find established in all the rest of the animal kingdom, that one might really believe that they are the remains of another order of things, the living relicts of that pre-existing state, whose other wrecks we can only discover in the interior of the earth; and that they have escaped by some miracle from those catastrophes which have destroyed their cotemporary species.

In this animal, the result of every singularity of organization seems to be only weakness and imperfection; and the inconveniences which they occasion to the animal seem not to be compensated by any advantage. The name of the animal is derived from the plaintive cry which he makes whilst moving, it sounds like the word Aï, and is repeated six times in ascending musical series.

A single glance at the proportions and the singular structure of particular parts of the Aï (*Bradypus Tridactylus*, Linn.) will sufficiently evince the propriety of these remarks. The arm and fore arm, taken together, are nearly twice as long as the leg and thigh; so that when the animal would walk on all four, it is obliged to trail along on its elbows. The pelvis is so wide, and the cotyloid cavities turned so backwards, that it cannot bring the knees together, but is obliged to keep the thighs wide asunder. Animals, in general, receive their chief impulse from the hind feet; good runners, as hares, having their hind feet long: but the long fore feet can only serve, as in the crab, to impede their progress; hence the sloths can only employ them to cling by, and to draw after them the hinder parts of their bodies.

This extremely wide pelvis differs from that of other animals, in the os sacrum having a second union with the other bones of the pelvis; it being joined with the tuberosity of the ischium, and thereby leaving only an opening instead of the great ischiatic notch. This latter structure is only observable in *Didelphus ursina*, of Shaw.

In the articulation of the hind feet, it appears as if it was intended to prevent the animal from having any power of using them. Instead of the articulation with the astragalus being a ginglymus, allowing the

foot to bend on the leg, there exists a conical pit in the top of the astragalus, in which the extremity of the fibula is inserted, like a pivot, the foot turning round like a vane on its staff. Added to this, when the leg is vertical, the foot is nearly in a similar direction, standing on its edge, so that the animal cannot place the sole of the foot on the ground, but by stretching out the leg until it has placed it in almost a horizontal direction.

The toes of the animal are inclosed, quite to the nails, in a stiff skin, which will allow only of their being bent and straightened all together. And to add to its difficulty in motion, several bones, which, in other animals, are always distinct, are here joined together. Thus the first phalanges of all the feet are united to the bones of the metacarpus and metatarsus. In this manner one bone fills the place of eleven, or even of seventeen.

The nails are of a monstrous length, and are weapons which, by enabling the animal to defend himself with considerable success, may be regarded as the only compensation for the disadvantages of the rest of its organization. But these animals, unable to draw back their nails, as the cats do, are obliged to curve them underneath, when they do not use them, and thus place their convex surfaces downwards. As in cats, so in the sloths, each claw is set, and retained in a bony glove-like sheath; but in the cats the upper part of this sheath is most advanced; whilst in the sloths, the lowest part is most forward.

In the Aï, different from all other quadrupeds, are nine cervical vertebræ; an extraordinary singularity, characteristic of this particular species, and not an accidental or monstrous formation. Thus in the same genus exists a most essential difference of structure.

The sloths, different from other animals, have no incisors. In the Aï, those teeth which might be regarded as the canine teeth, are not pointed, but are rubbed down obliquely: the upper ones backwards, and the lower ones at the sides. The teeth are most simple in their construction; being a cylinder of bone, surrounded by an envelope of

enamel, and hollowed at each end; at the other end by detitrion, and at the inner by defect of ossification. The enamel not entering into the body of the tooth, and the laminæ of osseous matter being ill connected, and consequently not firm, mastication must have been very imperfect.

The zygomatic arch would distinguish these animals from all others. The zygomatic apophysis of the temporal bone does not join that of the jugal, a considerable space existing between them: they both being disposed in such a direction, as never would allow them to unite. But a circumstance still more extraordinary is, that from the inferior edge of the zygomatic apophysis of the os jugale, a long apophysis descends obliquely, almost to the lower edge of the under jaw.

In the above digressive sketch, the more striking peculiarities in the bones of these animals are only noticed, as that will prove sufficient to allow of judging of the degree of affinity between them and the fossil remains, to the examination of which we shall now proceed.

The substratum in the Western part of Virginia, beyond the blue ridge, is a lime-stone, abounding with large caverns, the earthy floors of which are impregnated with nitre. In digging the floor of one of these caves, in the county of Green-briar, the labourers, at the depth of two or three feet, came to some bones, belonging to some animal which was to them unknown. The bones were, 1. A fragment of a femur, the two condyles being nearly entire; 2. A radius, perfect; 3. An ulna, broken in two; 4. Three claws, and half a dozen other bones of the feet. Mr. Jefferson, to whom we are obliged for the account of these curious remains, considered himself as not possessed of sufficient data to allow him to approximate these remains nearer to any existing animal, than by considering it as one of the unguiculated quadrupeds. Assuming, then, the lion, as the largest of the quadrupeds of this family, he considered it as the fittest animal with the bones of which he might compare the bones of the megalonix. But so large is the claw of this animal (seven inches and a half), that, as

Mr. Jefferson justly observes, if we were to estimate the size of this animal by a comparison of its claw with that of the lion, on the principle of *ex pede herculem,* it would give us a being out of the limits of nature*.

From comparisons, however, made with a fair attention to every consideration, he was induced to conclude that he might safely say, "That this animal was three times as large as the lion; that he stood as pre-eminently at the head of the column of clawed animals, as the mammoth stood at the head of the elephant, rhinoceros, and hippopotamus; and that he may have been as formidable an antagonist to the mammoth, as the lion to the elephant.

Dr. Wistar, professor of anatomy in the university of Pennsylvania, gave, in the same volume, a description of the preceding bones, to which he subjoined some illustrative observations. After having carefully examined these bones, almost in every point of view, Dr. Wistar concluded that there seemed to be some analogy between the feet of this fossil animal and those of the *bradypus.* Having, however, no opportunity of any other comparison with this animal than by the description given of it by M. Daubenton, he could not come to any decided opinion as to the degree of affinity. An unguis, described by M. Daubenton, and which had been presented by M. de la Condamine, as having belonged to a large species of sloth, seemed strongly, from its agreement in size, to confirm the affinity. This claw, though not entire, measured in length, round its convexity, six inches; and in breadth, at its base, an inch and a half†.

Both Dr. Wistar and Mr. Jefferson were disposed to doubt that any similarity existed between these fossil bones and those of the megatherium found at Paraguay; but for want of a good plate, or a full description of the latter skeleton, they considered themselves as unable to decide on the subject.

* Transactions of the American Philosophical Society, Vol. IV. p. 246.

† Ibid. Vol. IV. p. 526.

Faujas St. Fond, speaking of the megatherium, refers these bones, found at Virginia, to a similar animal, differing only in size, saying that the remains of animals of the same species, but of much less size, have been found in North America, and described by Mr. Jefferson.

Furnished with the necessary knowledge by the anatomical examinations referred to in the preceding part of this letter, and assisted by plaster casts of the American bones, described by Mr. Jefferson, and by two bones, and particularly by a tooth, with the examination of which he was favoured by M. Palisat de Beauvois, who had obtained them from the same cavern which had supplied those described by Mr. Jefferson, M. Cuvier was enabled to determine that these fossil bones were the remains of an animal of a species of sloth *(Bradypus)* hitherto unknown.

Their agreement with the bones of the sloth, or of the neighbouring genus the ant-eater, appears to be confirmed by the following characteristic circumstances. The articular face of the last phalanx, or ungual bone, has in its middle a well marked ridge, which considerably straightens the ginglimus with the adjoining bone. This is in perfect agreement with what occurs in the sloths and the ant-eaters; whilst, in the animals of the genus *felis*, or cat kind, the joints of the toes are more free, and this ridge is nearly effaced.

The upper part of this surface is prolonged farther backward than the lower; hence, the last bone could only be extended in a right line: it consequently could not be turned backwards with its point upwards, as in the cat kind; but might have been bent entirely underneath, with its convex part downwards, as in the sloths and ant-eaters. From these, and indeed other concurrent circumstances, it seems to be fair to conclude that this ungual bone was that of a sloth; but two other ungual bones, probably of the same foot, were found to differ in size from the former bone, as well as from each other. In this they differ both from the sloths and the cat kind, which have their nails nearly equal, and agree with the ant-eaters, in

which the nails are very unequal. In the other bones of this finger, a perfect accordance is observable; and still further evidence appears of the animal having been of the nature which had been supposed from the appearance of the ungual bone.

A puzzling circumstance occurred with respect to a metacarpal bone, answering to the ring-finger, which appeared to be half as long again as the metacarpal bone of the next, the middle finger. The explanation of this singularity appeared to be truly difficult. In the sloths, heteroclites as they are in other respects, nothing similar appeared. In the engraving of the skeleton of the megatherium, the same peculiarity was, however, found to be depicted.

It therefore now appeared not to be an accidental or monstrous conformation, and consequently something analogous might be expected to be found among the living animals. This indeed was found to be the case. In the *Myrmecophaga jubata*, one of the family of ant-eaters, the metatarsal of the middle finger is more thick and short than all the others; that of the index is a little longer and thinner, and that of the ring and of the little finger much more so.

From a pit on the outside of the metacarpal bone of the index, there appears reason for believing that a metacarpal bone of the thumb had existed in this animal. In the fore-foot of the megalonix, therefore, there would have been two complete fingers, the index and the middle fingers: and besides these, the vestiges, at least, of three more. But one of these three, at least, was more than a vestige, since there was a third ungual bone, which in all probability was that of the *annulare*.

The examination of the radius and of the ulna gave reason for concluding that they also had belonged to an animal of the sloth kind, and appeared perfectly to accord with the preceding bones of the fore-foot.

From the information yielded by the examination of the preceding bones, no doubt could exist of their having belonged to an animal

which might be considered as either belonging to the sloths or ant-eaters. In determining under which of these genera the megalonix should be placed, the tooth which had been obtained by M. de Beauvois was entirely decisive, since the ant-eaters have no teeth at all. An examination of this tooth showed also, that it was certainly that of a sloth; it possessing the same simplicity of structure, and the same hollow in its middle, produced by attrition on the central bony part of the tooth.

If the living analogue of this fossil animal existed, it could hardly, from the vastness of its size, have been hitherto concealed. The bones of its fore-arm are about a sixth longer than those of a common ox; and supposing that the other parts possessed at least the same proportion, the whole animal must have equalled the largest oxen of Switzerland, or of Hungary.

Plate XXI. Fig. 10, is the claw-bone of this animal, which was found in America. On the middle of its articular surface is a well-marked ridge, which necessarily restrained the motion of the joint. A similar ridge exists in the ant-eaters and sloths; but nothing of this kind is discoverable in the lion, or in any of the genus felis.

Plate XXI. Fig. 11, is the tooth found by M. de Beauvois, in the caverns in Virginia, as were the preceding bones. This tooth at once determines the genus to which this animal belonged. It is the tooth of an animal of the sloth kind. The ant-eaters have no teeth.

About the same time that the extraordinary fossil remains of the megalonix were found in North America, several bones, equally extraordinary and unknown, were found in the excavations made in the banks of the river Luxan, a league south-east of a village of the same name, about three leagues west-south-west of Buenos Ayres. These bones were sent to the Royal Museum at Madrid, in 1789, by the Marquis of Loretto, Viceroy of Buenos Ayres. The bones of a second animal of the same kind, which were found at Lima, were also sent to the same Museum in 1795; and the bones of a third, which had

been found at Paraguay, were presented by a lady to Father Fernando Scio. Thus it appears that the remains of this extraordinary animal exist in the most distant parts of Southern America.

On the first view of the head of this animal, the most striking agreement is observed with those of the sloths, and particularly with that of the aï. This is particularly the case with the long-descending apophysis placed at the anterior base of the zygomatic arch. This arch, which is interrupted in the sloths, is complete in the megatherium. The rising branch of the lower jaw resembles that of the sloths; but its lower part forms a convexity, of which but a slight resemblance is found in the elephant.

The bony muzzle is more projecting in this fossil animal, the Megatherium, than in the aï, in consequence of the advancing of the symphisis of the lower jaw. The bones of the nose are very short; which, from what takes place in the elephant and tapir, gives reason for suspecting that this animal had a trunk, which, however, there is also reason for supposing must have been very short.

The teeth are sixteen grinders, four on each side, in each jaw. They are of a prismatic form, and have their form crossed by a groove. The vertebræ are seven cervical, sixteen dorsal, and three lumbar. The megatherium, therefore, differs in the number of cervical from the aï, who we have seen differs in this respect from all the other quadrupeds, but agrees with it exactly in the number of the dorsal and lumbar. The number of the ribs are of course sixteen on each side.

The relative proportions of the extremities of the megatherium differ exceedingly from those of the sloths, and indeed from those of any known animal. In the sloths, we have seen that the length of the fore-extremities is double that of the hinder; but, in this animal, the difference is much less. But the great thickness of the bone of the thigh observable in the sloths, tatous, and pangolins, is carried to a much further extent in the megatherium; the length of the femur of this animal being only double its thickness. The inability of this

animal for leaping, or running, must be obvious: it could only have walked, and that slowly.

The scapula possesses, on a large scale, the same proportions as that of the sloths; and the clavicles which this animal possesses, with the unau, shows how widely it differs from the elephant, rhinoceros, and other large ruminants, which have not this bone; and with the length of the phalanges which carry the nails, prove that this animal employed its fore-feet for the purpose of seizing, and perhaps of climbing.

The humerus of the megatherium is remarkable for the width of its lower part, produced by the large surface of cristæ placed above the condyles, and serving for the attachment of muscles, which must have been very considerable, and of course must have given the animal prodigious powers in the fore extremities. This considerable width of the lower extremity of this bone is also found in the ant-eater, which employs his enormous claws to allow him to hang from the branches of trees, or to tear up the solid nests of the *termites*. In the ant-eater the width is three-fifths of the length of the bone, whilst in this animal it is a half, as it is also in the long-tailed manis *(manis tetradactyla)*. In the rhinoceros the width is only one-third, and in the elephant one-fourth of the length.

The olecranon of this animal is of such a length, as to give considerable power to the extensors; but, in the sloth, this bone is extremely short. The radius, as in the sloth, turns freely on the cubitus. In the skeleton at Madrid, and in its annexed representation, it must be observed that this bone has been reversed in the mounting, the humeral end being placed downwards.

The hand rested entirely on the ground whilst the animal walked. The visible fingers, armed with claws, are three in number; the two others being hidden under the skin, as in the aï, and as three are in the unau and two-toed ant-eater. The bones of the metacarpus are not joined together, as in the aï.

The bones of the pelvis differ much from those of the neighbouring genera. Those of the ilium, which are alone preserved in the skeleton at Madrid, form a large and widely-spread half basin, placed perpendicular to the spine, resembling that of the elephant, and still more that of the rhinoceros. From the form of the pelvis, it may be concluded, that the belly of the animal was large, and hence that its food consisted of vegetables.

The pubis and ischium are wanting in the skeleton; and, as M. Cuvier supposes, were lost: but if, on the contrary, this defect is natural, an approach to it will be found in the two-fingered ant-eater, in which the bones of the pubis are not united in the fore part.

The enormous thickness of the thigh-bone has been already noticed. The tibia and fibula are united at both ends, and yield together a vast surface. But one toe, armed with a claw, is seen in the hind-foot of the skeleton. In this respect M. Cuvier thinks there must exist room for doubt, since only two others are shown without claws: and his anatomical researches have taught him, that it is a rule without, hitherto, any known exception, that all the clawed animals have five fingers, existing either outwardly or within the skin, or reduced to their simple bony rudiments.

The tail is wanting in the skeleton; and the smallness of the posterior face of the os sacrum gives reason for believing that it was very short in this animal.

From a general view of the skeleton of this animal, so completely preserved, we are able to form well-founded conjectures as to the nature of the animal itself.

His teeth, M. Cuvier observes, prove that he lived on vegetables: and his fore-feet, robust and armed with sharp claws, point out that roots were his chief objects of search. His claws supplied him with arms sufficient for his defence. His progress was not swift, nor was it requisite that it should be, since he was not under the necessity of flying or of pursuing.

It would then, M. Cuvier adds, be very difficult to find, in the organization of this animal, the causes of his destruction; and yet, if he still exists, where can he be? or can he have escaped from all the researches of huntsmen and naturalists?

As far as an opinion can be formed from the few parts of the megalonix which have been found, there seems to exist in M. Cuvier's opinion, almost an identity of form with the megatherium; but the size, he observes, is different, the bones of the megatherium being one-third larger than that of the megalonix. This difference of size, he thinks, is a real specific difference; in confirmation of which, he observes, that the sheaths of the claws are more complete and long in the last phalanges of the megatherium than in those of the megalonix. To these, I think, may be added another difference, which M. Cuvier does not appear to have noticed. In the megalonix he found a tooth resembling the canine tooth of the aï, whilst the megatherium is only supplied with grinders.

There can, therefore, I think, exist no difficulty in agreeing with this celebrated naturalist, that these two animals formed two species of the same genus, belonging to the family of *edentata*, and requiring to be placed between the sloths and the ant-eaters, but nearer to the former than to the latter*.

Plate XXII. Fig. 1, represents the complete skeleton of the megatherium, as existing in the Royal Museum at Madrid.

* Ann. du Mus. Cat. 29, p. 387.

LETTER XXXI.

CAVERNS IN GERMANY AND HUNGARY, CONTAINING FOSSIL BONES ......GAYLENREUTH, &C......INQUIRY RESPECTING THE ANIMALS TO WHICH THEY BELONGED.......THE REMAINS OF TWO SPECIES OF BEARS DISCOVERED.

It has been with considerable pleasure that I have heard you describe the terrific magnificence of the caverns of the Peak, and of several other similar caverns in this island. But these must yield to the caverns of Germany and of Hungary, in which we have not only to admire prodigious subterranean excavations, embellished with stalactitic decorations, but to contemplate an inexhaustible accumulation of the remains of animals of a former world, some of which appear to be unknown to us in a living state.

Many of these caverns have been noticed by different authors. Bauman's Cave, near Blankenbourg, has been described by Leibnitz, *Protogæa*, p. 7; and Einhornshœle, in Scharzfeld, in Hanover, has been described by the same author, and by M. de Luc, in his letters to the Queen. In the chain of the Hartz are several also, which have been described by Behrens, in *Hercynia Curiosa.* Hungary, also, has several similar caverns, which have deservedly engaged the attention of several learned men.

Among the most remarkable of these caverns are those of Gaylenreuth, on the confines of Bayreuth. The opening to these, which is about seven feet and a half high, is at the foot of a rock of limestone of considerable magnitude, and in its eastern side. Immediately beyond the opening is a magnificent grotto, of about three hundred feet in circumference, which has been naturally divided by the form of the roof into four caves. The first is about twenty-five feet long and

wide, and varies in height from nine to eighteen feet, the roof being formed into irregular arches. Beyond this is the second cave, about twenty-eight feet long, and of nearly the same width and height with the former. In this cave the stalactitic crust begins to appear, and in considerable quantity; but not in such quantity as in the third cave, which is beautifully hung, as it were, with this sparry tapestry. The roof now begins to slope downwards; so that in the next, the last, of these caves, it is not above four or five feet in height. In the caves forming this first grotto, fragments of bones are found; and it is said that they were as plentiful here as they now are in the interior grottoes.

The passage into the second gretto is about six feet high and fourteen feet wide. This grotto, which extends straight forwards sixty feet from the opening, and is about forty feet wide, and at its commencement about eighteen feet high, would commodiously hold two hundred men. Its appearance is rendered remarkably interesting from the darkness of its recesses, and from the various brilliant reflections of the light from the stalactites with which its roofs and sides are covered. The constant drip of water from the roof, and the stalagmatic pillars on the floor, assist in perfecting the wonders of the scene. In this grotto no search was made for bones, on account of the thickness of the sparry crust.

A low and very rugged passage, the roof of which is formed of projecting pieces of rock, leads to the third grotto; the opening into which is a hole three feet high and four feet wide. This grotto is more regular in its form, and is about thirty feet in diameter, and nearly round: its height is from five to six feet. This grotto is very richly and fantastically adorned by the varying forms of its stalactitic hangings. The floor is also covered with a wet and slippery glazing, in which several teeth and jaws appear to have been fixed.

From this grotto commences the descent to the inferior caverns. Within only about five or six feet an opening in the floor is seen, which is partly vaulted over by a projecting piece of rock. The descent

is about twenty feet; and occasioned to M. Esper and his companions some little fear lest they should never return, but remain to augment the zoolithes contained in these terrific mansions. This cavern was found to be about thirty feet in height, about fifteen feet in width, and nearly circular: the sides, roof, and floor, displaying the remains of animals. The rock itself is thickly beset with teeth and bones, and the floor is covered with a loose earth, the evident result of animal decomposition, and in which numerous bones are imbedded.

A gradual descent leads to another grotto, which, with its passage, is forty feet in length, and twenty feet in height. Its sides and top are beautifully adorned with stalactites. Nearly twenty feet further is a frightful gulf, the opening of which is about fifteen feet in diameter; and upon descending about twenty feet, another grotto, about the same diameter with the former, but forty feet in height, is seen. Here the bones are dispersed about; and the floor, which is formed of animal earth, has great numbers of them imbedded in it. The bones which are here found seem to be of different animals; but in this, as well as in the former caverns, perfect and unbroken bones are very seldom found. Sometimes a tooth is seen projecting from the solid rock, through the stalactitic covering, showing that many of these wonderfnl remains may here be concealed. A specimen of this kind, which I possess, from Gaylenreuth, is rendered particularly interesting, by the first molar tooth of the lower jaw, with its enamel quite perfect, rising through the stalactitic mass which invests the bone. In this cavern the stalactites begin to be of a larger size, and of a more columnar form.

Passing on, through a small opening in the rock, a small cave, seven feet long and five feet high, is discovered: another small opening out of which leads to another small cave; from which a sloping descent leads to a cave twenty-five feet in height, and above half as much in its diameter, in which is a truncated columnar stalactite, eight feet in circumference.

A narrow and most difficult passage, twenty feet in length, leads

from this cavern to another, five and twenty feet in height, which is every where beset with teeth, bones, and stalactitic projections. This cavern is suddenly contracted, so as to form a vestibule of six feet wide, ten long, and nine high, terminating in an opening close to the floor, only three feet wide and two high, through which it is necessary to writhe with the body on the ground. This leads into a small cave, eight feet high and wide, which is the passage into a grotto twenty-eight feet high, and about three and forty feet long and wide. Here the prodigious quantity of animal earth, the vast number of teeth, jaws, and other bones, and the heavy grouping of the stalactites, produced so dismal an appearance, as to lead Esper to speak of it as a perfect model for a temple for a god of the dead. Here hundreds of cart-loads of bony remains might be removed, pockets might be filled with fossil teeth, and animal earth was found to reach to the utmost depth to which they dug. A piece of stalactite being here broken down, was found to contain pieces of bones within it, the remnants of which were left imbedded in the rock.

From this principal cave is a very narrow passage, terminating in the last cave, which is about six feet in width, fifteen in height, and the same in length. In this cave were no animal remains, and the floor was the naked rock.

Thus far only could these natural sepulchres be traced; but there is every reason to suppose that these animal remains were disposed through a greater part of this rock*.

Whence could this immense quantity of the remains of carnivorous animals have been collected, is a question which naturally arises; but the difficulty of answering it appears to be almost insurmountable.

It will not appear surprising, that these extraordinary accumulations should have considerably bewildered those who have attempted to explain their origin and formation, and have led them to the most extra-

* Description des Zoolithes nouvellement decouvertes d'animaux quadrupedes inconnus, et des cavernes qui les renferment, &c. par J. F. Esper. 1774.

vagant opinions. One of the earliest conjectures, after that of these caverns having been the dwellings of giants, dragons, and pigmies, and of their having been the temples in which sacrifices had been performed by the earliest inhabitants of these parts, was that they had been the retreats of robbers, and that these were the bones of those they had murdered. A more plausible conjecture was, that these had been the retreats of various carnivorous animals, and that the remains were of those animals which they had devoured. But even this conjecture possesses not the semblance of probability; since these are found to be chiefly the bones of carnivorous animals themselves, and consequently would be the remains, not of the victims, but of the destroyers. The more generally received opinion has been, that these are the remains of animals which, on the advance of the waters of the deluge, retreated hither for shelter, where they perished, and their bones have been preserved. The insufficiency of even this apparently more probable conjecture appears, when we recollect that these remains are almost of carnivorous animals alone; and still more so when we learn, as is the case, that more than three-fourths of these remains belonged to animals, not an individual of which is now known to exist.

The bones in the caverns of different mountains are all found nearly in a similar state. They are detached, scattered, often broken, but never rubbed down, as if by the action of water. They are lighter and less solid than recent bones, but yet retain their real animal nature, and still contain their gelatine. They have suffered but little decomposition, and are not petrified. Many of them are covered with a coat of earth, containing the remains of animal matter; and frequently they are not only covered, but impregnated and filled with stalactitic matter. In the earth in which many of them are imbedded, pieces of a bluish marble are found, with their angles rounded as if by bowldering, and which resemble those which help to form the bony breccia of Gibraltar and of Dalmatia.

To the unremitting labours of M. Cuvier we are indebted for almost every important information relative to the nature of these bones.

From the numerous specimens which he has obtained, he is enabled to state the astonishing fact, that these bones are similar, in the several caverns of an extent of more than two hundred leagues; that three-fourths of these bones belonged to species of bear not known now to exist; a half, or two-thirds of the other fourth, to a species of hyena now existing; and the remainder to some species of the lion or tiger, to the wolf, dog, fox, polecat, or some similar animals.

Kundman, Walch, Esper, and several others, have failed in their endeavours to determine to what genus of animals these bones had belonged. Bruckman compared them to those of the bear: and M. Fuchs was of opinion, that the fosssil skull very much resembled that of the polar bear, which opinion was opposed by the celebrated Camper. M. Rosenmuller appears to have been the first who obtained any correct notions respecting these fossils. His comparisons led him to the conclusion, that the bear of these caves was different from the brown bear, as well as from the white or polar bear. Camper appears to have proceeded a step further, and to have discovered, that among the bones of these caves were those of another species of bear, which he calls the true bear. Blumenbach perceived this difference in the fossil species, and in consequence named the one the *Ursus spelæus*, and the other *Ursus arctoideus*.

But it is to M. Cuvier that we are indebted, not only for a more distinct separation of these species from each other, but for an accurate comparison of the fossil with the several living species. He was supplied by M. Autenreith and Camper with the information which they possessed as to the fossils of Gaylenreuth; by M. Carsten with correct drawings of the specimens of Sundwich, in the Museum of Berlin; and he also had the full advantage of the Museum of the Landgrave of Hesse Darmstadt, and of several private collections. In addition to these he had immediate reference to the splendid collection of the fossils of Gaylenreuth, in the National Museum, which had been presented to M. Buffon, for the Parisian Museum, by the late Margrave of Anspach.

To enable himself to employ this rich fund of materials successfully in the investigation respecting the animals of the caves, he first devoted himself to a careful examination of the recent skeletons of bears, wishing to determine the number of their species, and to ascertain their respective differences. Thus he discovered that the bears of Europe were all referable to two species; the differences of which were discoverable in their forms, and particularly in the shape of the bones of the head; and that one, at least, of these species, was divided into several varieties, by the nature and colour of their hair.

The grand characteristic of one of these species is, the rounded form of the whole of the top of the head. The forehead forms a part of the same curve which extends from the muzzle to the occiput; and the sagittal ridge does not begin to show itself, but near to the occiput. To this species he refers the common brown bear of the Alps, Switzerland, Savoy, and the Pyrenees. To the variety inhabiting the Pyrenees, he considers that the golden bear belongs. To this species also belongs the Polish silver bear, and the terrestrial bear of Pallas.

In the other species, the frontal part of the skull is flattened, and even concave, particularly across. The ridges which part off the temporal fosse are strongly marked, and form an acute angle behind, which is prolonged into a highly-raised sagittal crista, which joins the occipital ridge.

To this second species he refers that which the naturalists have disdinguished as the black bear of Europe. He has only seen one of this species, which was of a considerable size, with coarse blackish brown hair, long and rather woolly

The black bear of America forms, in M. Cuvier's opinion, a third species. The skull, in this species, is shorter, in proportion to its thickness, and the zygomatic arches are less concave, and the small grinders more numerous, than in either of the preceding species. To this species belong several varieties. It appears that America produces also bears different from the common black. One is described of an enormous size, and with a grey skin. In the mountains of Gates, in

Indostan, M. Chapotin says there are bears marked on the chest with an eye-like spot.

The white polar bear *(U. maximus)* differs from all the rest in the form of its skull, which appears as if it were all of one piece; and instead of rising higher than the face, appears, on the contrary, to be rather lower. The post-orbital apophyses of the frontal bones are short and obtuse, the temporal ridges hardly perceptible, and the zygomatic arches stand much less out than in any of the preceding. The head is, in a word, more cylindrical, and more approaching in its form to that of the martin or polecat, than to that of the common bears.

In every species of bear the number and form of the teeth are nearly similar. There are six incisors in each jaw. In the upper jaw the two outer ones are strong, pointed, and directed rather outwards, with a rising behind, which descends obliquely forwards, from without inwards, and terminates so as to leave a slight notch on their inner bases. The four intermediate ones are a little pointed at their fore edge, and have behind a kind of spur, divided by a notch into two lobes.

The two external incisors of the lower jaw are wide, but pointed, and with a lateral lobe, deeply separated, at the outer bases. The two next have their base carried more behind, more towards the inside of the mouth than all the others: they are ridged, and marked on their posterior slope with two grooves, which terminate in two notches, the outer one of which is deepest; and the inner one is sometimes wanting. The middle ones are the least, and have only one notch, a little more towards the outside than the middle.

In the upper jaw there are three large grinders, and in the lower four; before which there are, in both jaws, a variable number of smaller ones.

In the upper jaw, the hindmost is the largest; it is oblong, narrowest behind, with its crown irregularly wrinkled. Forwards, on its outer edge, it has one middling-sized and two large eminences: and, on the inner edge, three or four middling-sized eminences, which

are sometimes very much reduced. The posterior extremity is merely crenated. This tooth has four roots, the foremost conical, two lateral, rather compressed, and one behind very much so. Plate XXII. Fig. 2, represents this tooth of its natural size, as found in the caverns, as were all the specimens from which the following figures were taken. The penultimate, or middle upper grinder, is rectangular, and has two large conical eminences on the outer side, three of which are less marked on the inner side, and one small one on the outer side behind. It has three roots, two external, and one stronger internal. Plate XXII. Fig. 3. The antepenultimate, or foremost grinder, is triangular, with three conical eminences, two external and one internal. Plate XXII. Fig. 4.

Before this tooth, in the existing species of bears, is a small simple tooth; and after a certain interval, and almost under the canine tooth, is another smaller.

In the lower jaw, the hindmost is a roundish oval: its crown is irregularly wrinkled, without distinct tubercles. It has but one root, which seems to be continuous with the crown, and is always compressed; one or two grooves giving the appearance of the commencement of a division. Plate XXII. Fig. 5. The penultimate is, in this jaw, the largest tooth; it is rectangular, and irregularly embossed: four or five eminences may be counted on the internal border, and four on the external, two of which are most marked. There is a transverse rising from the largest external eminence to the internal. This tooth has two roots; one conical, standing forwards; the other stronger, and compressed in the back part. Plate XXII. Fig. 6. The antepenultimate is more narrow than the preceding, and has its eminences more strongly marked: these are, one forwards, then one external, answering to two internal; then three behind, forming a triangle, and sometimes four. It has but two roots, one before and one behind. Plate XXII. Fig. 7. The foremost lower grinder is short, and a little compressed. It has a strong conical eminence in the middle, a low one forwards, and two small ones on the inner side behind. It has but two roots. Plate XXII. Fig. 8. One, and some-

times two very small teeth, are found at the root of the canine teeth, as in the upper jaw, in the existing species of these animals. The fossil canine tooth is represented of its natural size. Plate XXII. Fig. 9.

The teeth which are found in the fossil jaws differ from those of the recent animals only in their being larger and less worn down. But a more striking difference between the teeth of the bear of the caverns and the existing bears is, that the former has very rarely the small molar tooth, or teeth, immediately behind the canine tooth, whilst the latter possesses it at every age. Another, and a still more constant difference, is the small molar tooth placed immediately before the first large grinder in the upper jaw. Neither this tooth, nor its alveolus, has been seen by M. Cuvier in any of the fossil skulls, nor does it appear to have been seen by any other writer on these fossils.

The examination of the teeth determine the skulls found in these caves to have belonged to the genus bear: the general conformation of the skulls also show it, and at the same time manifest those characters which belong to the great family of carnivorous animals—such as a transverse and partly cylindrical condyle, a large and elevated coronoid apophysis, a zygomatic arch, very convex outwardly and rising upwards, with an orbit incomplete in the back part, and there confounded with the temporal fossa.

The fossil skulls found in these caverns appear to be of two species. The one has a strong rising of the forehead from the root of the nose, with two bumps on the forehead, a great length of the sagittal ridge, and a considerable projection and speedy approximation of the temporal cristæ. The other has the forehead flat, approaching in this respect to that of the black bear of America, but being a third larger: the vertical elevation of these skulls is also less, and the muzzle is longer; neither do they possess those three small teeth which are frequently found in the skull of that animal. M. Cuvier, indeed, concludes that the two species of skulls found in these caverns differ from all recent skulls, and equally as much from each other.

The under jaws found in the caverns also show, that here are the

remains of two species of bears: besides less differences, the coronoidal apophysis is much wider in the more common of the two species than in the other, the width being as ten to eight, although the teeth are a little larger in the latter species. M. Cuvier was disposed to arrange the latter species with the rounded skulls; but on considering that the rounded skulls were most frequent, and this species of jaws most rare, he found it difficult to determine on this point.

No remains of scapulæ have been found of sufficient size to allow any judgment being formed respecting the animal to which they belonged. Two sorts of os humeri have been found, as figured by Mr. John Hunter, *Trans. Phil.* 1794, Pl. xx. both belonging to the bear, but the one differing from the other in having a hole above the internal condyle for the passage of an artery, much resembling, in this circumstance, the os humeri of some animals of the genus *Felis*. Of the radius, the ulna, and the bones of the pelvis, nothing particular can be ascertained. Two kinds of ossa femoris, both decidedly of the genus *Bear*, but one much shorter and thicker than the other, have been found. A tibia has also been found, which, from its being thicker in proportion to that of the common bear, M. Cuvier is disposed to place with the preceding os femoris. With this bone he also places part of a fibula which is in the Museum.

Like the present bears, and several of the carnivorous animals, the bears of the caverns have seven carpal bones; and which, with the metacarpal bones, differ very triflingly from the bones of the existing bears. A similar agreement with those of the existing bears is observable in the tarsal and metatarsal bones.

Numerous vertebræ are found in these caverns, the greatest number of which appear to agree very closely with those of the existing bears. The last dorsal vertebra was, however, found under two distinct forms: one resembling that of the brown bear, and the other approaching to that of the polar bear, especially as the posterior supernumerary apophyses were not so long as the articular ones. Here

M. Cuvier supposes the same division of species to be evinced as appeared by the head and jaws.

From the strictest comparison of the rich collection of these fossil bones, to which he had access, with each other, and with the skeletons of existing species of bears, M. Cuvier considered himself authorized to make the following conclusions:

1. The bones which are most commonly found in these caverns, examined each separately, belong to the genus *Bear*.

2. The skulls, and some of the large bones, present such differences as should induce us to consider them as proceeding from species of bears different from those which naturalists have hitherto described.

3. These skulls, and some of the large bones, the os humeri and femoris for example, differ sufficiently among themselves to allow us to believe that the bones of two different species of bears have been here confusedly buried together.

4. Some of the bones of one of these species are more like to those of the bears of the present day than those of the other. There are even bones, among those of the one, as the os humeri, &c. which are not to be distinguished, if seen by themselves, from those of the common bear. There are others, in both species, which appear to be thus circumstanced, as those of the carpus, &c.

5. But the skulls are sufficient to furnish such characters as leave no reasonable doubt; and as those fossil skulls, which have the forehead tumid *(bombé)*, appear to be separated from our common bears more than the fossil skulls with a flat forehead, it is natural to refer to the former those fossil bones of the limbs which differ in the same degree from their analogues in our common bears. The bones of the body or limbs, which more resemble those of these latter animals, are more safely referable to the species with a flat forehead.

But to complete our knowledge of the skeleton, as M. Cuvier observes, it would be necessary to have all the bones of each species, which at present is not the case, we only having, under two forms,

the skull, lower jaw in part, os humeri, os femoris, and the last dorsal vertebra. The other bones having been found only under one form, it therefore cannot be decided to which of the two species they ought to be referred.

Time and assiduous research may fill up these chasms; but the general result is not less certain, in that which respects the existence, in these caverns, of bones of *two species hitherto unknown among the living species of bears.*

The species with the raised forehead, Blumenbach, Rosenmuller, and Cuvier, agree in designating as *Ursus spelæus;* and for that with the flat forehead Cuvier proposes the name *U. arctoideus.*

The remains which I possess of these animals are, a perfect skull, the half of an under jaw, and several well preserved parts of very large jaws, all of which appear to have belonged to *U. spelæus.*

LETTER XXXII.

INQUIRY CONTINUED....REMAINS OF CARNIVOROUS ANIMALS FOUND IN THE CAVERNS OF GERMANY, &C....HYENA....IN GAYLENREUTH, CANSTADT, &C... ..SPOTTED PANTHER.....ANIMAL RESEMBLING THE FOX....ZORILLA, OR POLECAT OF THE CAPE....WOLF, OR DOG....REMAINS OF CARNIVOROUS ANIMALS FOUND IN THE PLASTER QUARRIES NEAR PARIS....SARIGUE OF AMERICA....AN ANIMAL OF THE GENUS CANIS......ONE APPROACHING TO THE CIVET.......ANOTHER, SOMEWHAT RESEMBLING THE LARGE OTTER........ANOTHER, ENTIRELY UNKNOWN.

THE following observations on the fossil remains of those which may be more strictly regarded as carnivorous animals, are extremely interesting. Whilst placing them before you, I must again acknowledge my obligations to the zealous labours and perspicuous relations of M. Cuvier, who has assiduously worked, and with his usual success, the rich mine which lies open to him.

The fossil remains of hyenas, it appears, have been found, not only in the same caverns which contain the bones of bears, but in the same alluvial beds in which are found the remains of elephants.

Their remains are found in the cavern of Gaylenreuth. In the elegant work of Esper, already referred to, an atlas, Pl. III. Fig. 1, is attributed by him to this animal, which, however, appears to have belonged to the bear; and, on the other hand, two teeth, Pl. X. Fig. *c*, *d*, which are supposed to have belonged to the lion, are certainly those of the hyena. Collini, *Memoires de l'Academie de Manheim*, Tome *V*. Pl. II. has represented the skull and half of a lower jaw, found near the surface of one of the mountains which border the valley in which is situated the village of Eichstædt. This skull he describes as having belonged to some unknown species of phoca; but from the number and figure of the teeth, as well as from the remarkable elevation of the sagitto-occipital crista, no doubt can exist of its being the skull of the hyena. Kundman also figures a tooth, which he took himself from the rock in the cavern of Bauman, and which he supposes to be that of a calf, but which is undoubtedly that of a hyena. M. Cuvier has also received the remains of this animal from the valley of Neckar, near to Canstadt, so famous for the quantity of elephantine remains which are there found.

Thus it appears that the fossil remains of the hyena have been found in four different parts of Germany. In France also, at Fouvent, near Gray, in the department of Doubs, the remains of this animal have been found; and, as at Canstadt, mixed with the bones of elephants and horses.

The fossil bones of Canstadt were first found in the year 1700, and considerable researches made for them by order of the then reigning Duke of Wirtemberg. A dissertation was also written on them*, in which, however, but little information is afforded; the author, Dr. David Spleiss, having chiefly engaged himself in determining, whether these fossils were really the remains of animals, or merely the sports

* Oedipus Osteolithologicus.

of nature. These bones having been, however, preserved in the Museum of Stuttgard, M. Autenrieth favoured M. Cuvier with a particular account of them, and of the situation in which they were found.

The place is situated about a mile from the small city of Canstadt, on the eastern ridge of Neckar; the bones are found in disorder, partly broken, in a mass of yellowish clay, mixed with small round grains of quartz and bowldered limestones, with a quantity of small white fresh-water shells*.

This mass appears to occupy the bottom of the valley of Neckar, between the calcareous beds, and joins at the bottom of the hills of red marl which surround the mountains of freestone. These hills of marl appear to be older than the limestone, and the limestone older than the clay. The marl contains plants of the reed family; and the summits of these hills are covered with marine petrifactions, such as belemnites and ammonites; of which, however, there are none in the beds of limestone.

The bones of elephants were found nearest to the surface; the others were situated deeper. The bones of at least five elephants are preserved. There were whole cart-loads of the teeth of horses, but not a tenth part of the bones of the horses to which the teeth had belonged. Some bones of rhinoceroses were also found; and the epiphyses of such large vertebral bodies, as could only have belonged to some of the cetaceous animals.

In this clay were also found the skull of a hyena, the left half of another skull, the temporal bone of another of the same species, eleven grinders, four canine teeth, and twelve bones of the toes.

M. Autenrieth has also discovered, in the neighbourhood, an entire subterranean forest of palms, many of which are two feet in diameter.

* The circumstance of meeting with fresh water, and even land shells, among the fossil remains of land animals, frequently occurs. Thus the shell, Plate XIV. Fig. 9, apparently *Helix arbustorum*, was found among the remains of deer, at Brentford, in a stratum of light calcareous earth, reaching from sixteen to twenty-five feet from the surface. The fossils, in this instance, had been, in all probability, cotemporary. Other instances, however, occur, in which we find the remains of animals of different eras intermingled: a circumstance which, I conceive, proceeds from the intermixture of the *debris* of different strata.

The yellow clay is found in many other branches of this valley, and fossils are met with there very frequently.

In the year 1800, M. Tourtelle, of Fouvent-le-Prieure, a little village near Gray, in the department of Upper Saone, excavating a limestone rock, to extend his garden, found, in a fissure of the rock, various uncommon bones of different shapes and sizes. The excavations being increased, several more bones were found, and transmitted to the National Museum. These bones were chiefly of the jaws of elephants and of horses; but, amongst them, M. Cuvier also found a fragment of the lower jaw of the left side of a hyena, containing four grinders; a mutilated canine tooth, and the inferior part of a humerus, well preserved.

M. Cuvier, from the accurate knowledge which he possesses in comparative anatomy, has been enabled to discover that the fossil hyena is of a different species from the common one of the Levant. The last molar tooth of the lower jaw, in the known hyena, is distinguished by a strongly marked conical point on the anterior inner angle, and which projects inwards towards the palate: but, in the fossil corresponding tooth, this projection does not exist.

M. Cuvier was enabled to determine the fragment of a lower jaw, with the four molar teeth, to belong to the genus *Hyena;* but he was also led to believe it to belong to a different species from the common hyena, from the three anterior teeth possessing a less longitudinal extent, in proportion to their width and height, than is observable in those of the common hyena, and from their lateral points being less developed, and particularly the anterior one, which was entirely wanting in the second tooth; although it is very distinct in the common hyena. Calculating from the size of some fossil teeth, both from Canstadt and Fouvent, M. Cuvier concludes, that the animal to which they belonged must have exceeded the size of the common hyena one-fifth.

In a fragment of the upper jaw, from Gaylenreuth, he found the third molar tooth, which, though decidedly of the hyena, was analogous with the fossil teeth of the preceding lower jaw, in being short from front to

back, in proportion to its height and transverse diameter. Its anterior tubercle was entirely wanting, and its posterior hardly perceptible.

From these characters he is led to think that the fossil hyena had the muzzle much shorter in proportion, than the hyena of the Levant, by which it must have bitten stronger; which is not easy to conceive, since the hyena is known never to quit its hold. The Arabs, when speaking of one obstinate in his opinion, call him the head of a hyena. Calculating the size of the hyena to which the last-mentioned fragment belonged, M. Cuvier believes that it also must have exceeded the common hyena of the Levant one-fifth in size.

The confirmation of these bones having belonged to a species of hyena was obtained by the appearances yielded by the other bones, and particularly by the portion of the humerus, and by an astragalus. The difference of species, between the fossil hyena and that of the Levant, was also plainly shown by these specimens.

Besides these remains of the hyena, M. Cuvier obtained, from Gaylenreuth, the side jaw, with four grinders, very little injured, and the articular condyle and lower edge quite whole. By comparing this jaw, which was of an aged animal, with that of the hyena of the Levant, it was found to exceed it, in the proportion of three to two.

There, however, remained two more living species, with which it was desirable these fossil remains should be compared. The skin of one of these, the hyena of the Cape, being in the Museum, with the teeth preserved in it, M. Cuvier made a comparison of the teeth, and was very much surprised at finding a precise agreement between the fossil teeth and those of this animal. Consequently, as M. Cuvier remarks, if the fossil hyena has its analogue in this world, it is to be sought for in the hyena of the Cape.

He then proceeds to observe, that it is hardly necessary to mention that the resemblance between the teeth does not absolutely prove the perfect identity of the species, and that there might be differences between the skeletons, and even between the integuments. But even ad-

mitting this identity, in what a new labyrinth are the geologists placed!

It has been hitherto said that the fossil elephant is of the Asiatic species; and here we find it twice associated with an animal of the South of Africa. This same animal is found too associated with bears, which at present exist only in the north. At what time, then, he asks, was it that the elephants and the hyenas of the Cape, of the size of our bears, lived together in our climate, and were shaded by forests of palms, and in which they took shelter in caverns along with bears as large as our horses?

The remains of a very large animal of the genus *Felis* also exist in great numbers in these caverns. Those of Hungary have been described and figured by Vollgnad, *Ephem. Nat. Cur. An.* 4, *Dec.* 1. and Leibnitz gives the portion of a skull, *Protog.* Pl. XI. Fig. 1. This skull, which has been examined, and compared with the utmost degree of precision by M. Soemmerring with the skulls of the bear of the cavern and of the lion, is found by that celebrated anatomist to agree with that of the lion of a moderate size, and to differ from that of the bear of the caverns in thirty-six different points. But it is remarked by M. Cuvier, that the greater part of these points of difference are referable to every animal of the genus *Felis*, as well as to the lion. Esper has given the figures of several teeth, which resemble those of some feline animal, and which he obtained from the caverns of Gaylenreuth. M. Cuvier has also obtained, from Gaylenreuth, the second upper grinder; and, by favour of Mr. A. Camper, the half of a lower jaw, wanting only the condyle and the antepenultimate grinder of some animal of the same genus.

To determine to what species this jaw belongs, M. Cuvier justly observes, is by no means easy. "I venture to say," he adds, "that it would be impossible, without the numerous means of comparison which I have had the happiness of bringing together." By these opportunities he has been enabled to determine that this piece belonged to neither

the lion, lioness, nor tiger, and still less to the leopard and small panther, as it is called; and that if it must be referred to a living species, it can only be to the *jaguar*, or great spotted panther of South America.

Among the bones of Gaylenreuth which had undergone a considerable change, and which were invested with the same tufous matter as the bones already mentioned, M. Cuvier found several belonging to the fox, or to some animal nearly allied to it: and these bones, he believes, are by no means rare in the caverns.

In the same mass of tufa in which he found the preceding bones, resembling those of the fox, he found the remains of a smaller carnivorous animal, which he thought were certainly the bones of a martin. The dorsal vertebra, thus found, appeared to agree with those of the zorilla, or the polecat of the Cape—an agreement particularly remarkable, since the bones of the hyena of the caverns also bear a strong resemblance to those of the spotted hyena of the Cape.

From this concurrence, M. Cuvier had been almost led to think, that the analogues of the animals found in the caverns were perhaps to be found at the Cape; but this notion was entirely set aside by discovering that the fossil pelvis, found among these remains, more resembled that of the polecat of Europe.

The fossil bones which M. Cuvier found in the caverns, possessing no characters distinguishing them from those of animals still living in the same countries where these remains are found, were those of the wolf or dog. But it is necessary to remark, that this occurs in a genus where the distinction of species, by separate bones, is almost impossible. Daubenton had already remarked the difficulty of distinguishing the skeleton of a wolf from that of the shepherd's dog of the same size; and M. Cuvier has only been able to remark, that in the wolf the triangular part of the forehead, behind the orbits, is a little narrower and flatter, the sagitto-occipital ridge longer and more raised, and the teeth, particularly the canine, a little larger in proportion—

shades of difference so slight, as almost to lead to the opinion of the wolf and the dog being of the same species.

Esper and Rosenmuller describe bones found at Gaylenreuth, which they refer to the wolf. A skull of this kind is in the cabinet of Darmstadt, and is figured by Cuvier, *Ann. du Mus. d'Hist. Nat. Cap.* LIV. Pl. 34. Whichever species these bones belong to, they are found to agree, in the state of preservation, and in the substance with which they are invested, with those of the bears, and of the hyenas. Similar bones have been found with the elephantine remains at Carnstadt and at Romagnano; and at Kahldorf, where the head of the hyena already mentioned, described by Collini, was found.

The quantity of remains of animals of the former world which has been imbedded in the quarries of plaster-stone in the neighbourhood of Paris, must be beyond conception. Considering that, in certain beds, there is not a block of gypsum but which encloses perhaps a bone, how many millions of these bones, as is justly observed by Cuvier, must have been destroyed by the vast excavations which have been already made? how many more are being perpetually lost through mere neglect? and, even since they have been more in request, how many must escape observation, in consequence of their minuteness?

To such observations the indefatigable Cuvier was led, by the discovery of a skeleton of a small size, in two pieces of gypsum. By a careful dissection, as it were, of these stones, he was enabled to make out the different parts of the skeleton so distinctly, as to ascertain that it was one of the animals of the family of ***Pedimanes*** of Dumeril, which are distinguished by having a separated toe to their hind foot, and a fold of the integument forming a pouch beneath the belly; or, as it were, a false uterus.

The animals of this description are disposed, in the last edition of *Systema Naturæ,* in thirteen species, under the genus *Didelphis.* This disposal, according to M. Cuvier, is not correct. Independent of other objections, which will be presently noticed, it is to be remarked, that

Dr. Shaw has found it necessary to separate from these the kanguroo, *Didelphis gigantea*, Linn. and has formed of it a distinct genus, to which he has given the name *Macropus;* the animals of which transfer their young, even before they are fully formed, to a pouch beneath their belly, or carry them, when formed, on their backs.

M. Cuvier divides the genus *Didelphis* into the following subgenera :

I. *Sarigue*, with ten incisors, the middle a little the longest, in the upper jaw, and eight in the lower jaw ; the canine teeth long and pointed ; the tail naked and prehensile, Here he places the following species : 1. *Didelphis marsupialis* and *carcinophaga*, Linn.; *Did. virginiana*, Penn. *Did. opossum*, Linn. *Did. murina*, Linn. *Did. cayopollin* and *dorsigera*, Linn. *Did. brachiura*, *Did. memina*.

II. *Dasyure*, with eight incisors above, and six below ; a tail furnished with long hair, and not prehensile. The only species which is referred here is *Did. macuata*.

III. *Phalanger*, with six incisors above, and two long below, directed horizontally forwards ; three or four canine below, hardly passing out of the gums : the second and third toes of the hind feet, and sometimes the fourth, joined together to the claw. Here are brought *Did. orientalis* and *Did. volans*.

M. Cuvier agrees with Dr. Shaw in separating the kanguroos from the genus *Didelphis*.

From the elevation of the coronoid apophysis above the condyle, and the sharp projection formed by the posterior angle of the lower jaw, M. Cuvier drew his first inference, that this fossil animal belonged to the order of carnivorous animals.

The elevation of the condyle much above the horizontal line on which the teeth are placed, prevents these remains from being attributed to the carnivorous animals with teeth with a cutting edge, such as the dog, cat, ichneumon, weasel, badger, &c. which have the condyle nearly in a line with the teeth. This circumstance brings this fossil animal among the small *pedimanes* or *plantigrades*, or

among the insectivorous animals generally, and this we shall see confirmed by its teeth. But the hedgehog, the shrew, the mole, the *didelphis*, and some of the bats, have their condyles placed in a similar manner.

The great height and width of the coronoidal apophysis referred these remains more particularly to the subgenus or species *Sarigue*. The mole has it as wide, but it is lower, and placed in a different direction: *Did. murina* has it of the same proportions as to width, but the height is a little less. In this last circumstance it seemed to approach nearest to the hedgehog.

The sharp projection at the angle of the jaw also agreed with that of the hedgehog. In that of *didelphis* there is a particular circumstance: this projection bends inwards, with all the inferior edge of this part of the jaw; and by carefully removing the surrounding stone, M. Cuvier discovered this characteristic peculiarity in this fossil jaw.

The examination of the teeth confirmed that which was taught by the appearances of the jaw, since they possessed the general characters of the teeth of insectivorous animals, characters absolutely proper to the pedimanes, and, above all, to the sarigues. They were beset with pointed tubercles, and not with cutting edges, nor a flat crown.

After carefully comparing the teeth of the fossil jaw with those of the other pedimanes, he concluded that they agreed with those of the *dasyure*, those animals of New Holland of the genus *Didelphis*, with a tail furnished with long hair, and not prehensile, and with the common *sarigue* of America: but to which of these animals they approached the nearest he was unable to determine.

Examining the other parts of these fossil remains, he found, that their numbers, forms, and proportions, fully agreed with those of the *pedimanes*. Thus he found thirteen ribs, and thirteen dorsal vertebræ; six very long lumbar vertebræ, filling the space of six of the dorsal; the sacral vertebræ, and those of the beginning of the tail, possessing very large transverse apophyses; the radius and ulna very distinct,

and capable of moving easily on each other; the fibula separate from the tibia, having a thin and enlarged head; the triangle of the scapula nearly similar;—in a word, nothing which appeared in this skeleton manifested any important difference between it and that of the *sarigue*, and especially of *didelphis murina*, with which, it being of the same size, it was carefully compared.

The animals with a pouch, different from all other animals, have two long and flat bones, which articulate with the anterior edge of the pubis, and serve to support the edges of the pouch. M. Cuvier, therefore, dissected the stone with a point of a needle, and was thereby enabled to prove the existence of these supernumerary or marsupial bones in the fossil, and to determine that they agreed with the analogous bones in the *sarigue.*

The *tapir* is the only known American animal hitherto found fossil in Europe, M. Cuvier was anxious, therefore, to determine whether the *sarigue* might or not be considered as the second: believing that, of the genera of animals belonging to Austral Asia, none had been discovered fossil in Europe.

The *sarigues*, properly so called, with a scaly prehensile tail, ten incisors above, eight below, and large canine teeth, with the great toes of the hind feet detached and without a c'aw, are the animals of this genus which M. Cuvier considers as the American marsupial animals; and whilst Austral Asia produces all the rest of these animals, these, the *sarigues*, are produced in America alone. His task he considered, therefore, as only half performed, until he could determine whether these remains belonged to a *sarigue* or a *dasyure*.

He found that the *dasyure* has four toes nearly equal, the large one being so short that the skin almost hides it, it appearing only like a tubercle; but in the *sarigue* this toe is long and well marked, the other toes being unequal; the little toe, and particularly its metacarpal bone, being shorter than the others. By carefully exploring the stone, he found the fourth and fifth metatarsal bones, and ascertained that the

fifth, or that of the little toe, was a third shorter than that of the next toe, precisely as in the *sarigue*. Thus the question was fully decided, and it was proved, that *there exists in the quarries of plaster-stone the bones of an animal, the genus to which it belongs being at present proper to America.*

The eager inquiries of this illustrious naturalist did not rest here: he next endeavoured to discover if these remains agreed with any living species. But as the history of all the species is not known, this task was not expected to be satisfactorily accomplished. He, however, discovered, that it did not exactly agree with that of any of the known species; but that the *Didelphis murina* was the only one to which the fossil nearly approached in its size. It could not, however, be a skeleton of an animal of this species, since there are essential differences in their proportions, some parts being smaller, and others larger, in the one than in the other.

A jaw was found in the plaster quarries, which at first sight appeared to resemble the jaw of a dog or of a fox. From its elevated condyloid apophysis, the notch in its posterior edge forming the arc of a circle, its posterior angle being hooked, and from the cutting, triangular, dentelated molar teeth, M. Cuvier had no hesitation in classing the animal to which it belonged with the carnivorous; and, from the number of the molar teeth, he ascertained that it must also have belonged to the genus *Canis*. But after much careful examination, he was unable to discover any species of the genus *Canis*, with whose jaw the fossil species agreed in every respect: he, therefore, thinks it very probable that this carnivorous animal, like the herbivorous of these same quarries, belonged to some species at present unknown. He also found the astragalus of another carnivorous animal, much smaller than would have been the astragalus of the animal to which this jaw belonged.

He afterwards found, in the great quarry of Montmartre, a fragment of a lower jaw, very different from that of the dog. In this piece there only remained a complete tooth and the fragment of another;

but, by a most careful and nice examination and comparison, he was enabled to ascertain that it belonged to some species of the genus *Canis*, the skeleton of which is unknown; or to some carnivorous animal between the genus *Canis* and *Viverra genetta* and *ichneumon*.

The lower head of an os humeri was obtained from the same quarry, and appeared to have belonged to a species of martin about the size of a common cat. If it belonged to the same animal to which the preceding jaw did, M. Cuvier remarks, that it must have been of a genus entirely distinct from the other carnivorous animals.

A small astragalus was also found, resembling that of the cat or of the ichneumon, and which very probably belonged to the same animal as the humerus.

An ulna was also found, belonging to some carnivorous animal, and of those species which have short legs, as the otters, &c. but larger than those of the largest sea-otters. From this bone alone, he does not hesitate in saying, that the animal to which it belonged is unknown to naturalists.

A metacarpal bone was found also at Montmartre, which in its thickness agreed with that of the cats, ichneumons, and otters; but being double the size of the analogous bone in the otter, he thinks it may be considered as belonging to the same animal as the ulna.

Thus, then, M. Cuvier appears to have discovered the remains of three carnivorous animals in the plaster quarries; and M. Camper possesses a metacarpal bone, which is of the same proportional length as that of the dog; but its absolute size is such, as will not allow of referring it to any of the species whose fragments have been obtained. This points out a fourth fossil carnivorous animal in these quarries. These, with the small *sarigue*, are all which have been there discovered of this class.

LETTER XXXIII.

FOSSILS CONSIDERED IN CONNECTION WITH THE STRATA IN WHICH THEY ARE CONTAINED.

I HAVE now arrived at the termination of my proposed attempt, having placed before you as correct a sketch as I was able of the fossil remains of those organized beings, which existed on this planet previous to its possessing its present form.

Your attention has been hitherto called, chiefly, to the original modes of existence of those beings, and to the nature of the changes which they have undergone. You have seen, that some of these remains have belonged to beings whose living analogues may still be found; whilst others have belonged to beings differing essentially from any which are now known to exist, and in those particular characters which are employed by naturalists as marking generic difference.

You have also seen, that the fossil remains of both vegetables and animals have undergone the most extraordinary changes. I have endeavoured to prove to you, that most vegetable fossils had undergone a process of bituminization, by which their conservation was secured, previously to their impregnation with earthy or metallic salts. I have also suggested the probability of a correspondent preparatory change in many animal substances, previous to their mineralization.*

* In addition to the instances which have been already adduced in proof of the petrifaction of vegetables having been in general affected by the impregnation of previously bituminized vegetable matter, with earthy or metallic solutions, and not by substitution, I have met with one striking fact. I two years since obtained from the shore at Walton, wood changed into marble, capable of receiving a beautiful polish, and which, on being deprived of its carbonate of lime by the action of muriatic acid, left the light, inflammable, bituminous wood, possessing a volume very little less than that of the marble in which it had been contained.

Other important circumstances respecting the situations in which these fossils are found must also have excited your attention. From the integrity of numerous delicate fossil shells, and from the congregation of numerous similar animals in a fossil state, it has been evinced, that these animals must have lived on the very spots in which they are now found imbedded. It has been also shown, that these fossil remains are found in those parts of the world in which no similar beings now exist, and in climates in which it is presumed that they could not live; that the remains of numerous unknown plants are found in the neighbourhood of coal, at considerable depths; and that the remains of marine animals are found in very lofty mountains, as well as far beneath the surface of the earth.

The consideration of these circumstances must have filled your mind with wonder, and have led you to regard with reverence these stupendous proofs of the power of the Almighty creator. But from the consideration of these circumstances alone, but little information can be obtained respecting the age or formation of this planet: to obtain any useful knowledge on these subjects, it is necessary that the examination of these fossil bodies should be connected with that of the strata in which they are found.

For calling the attention of geologists to this mode of directing their inquiries, we are much indebted to Mr. William Smith, who, long since, not only pointed out the necessity of ascertaining the fossils belonging to each particular stratum, but also collected and preserved for the information of others, specimens of numerous strata, with some of their peculiar fossils.

Without the hope of making any important addition to our knowledge of these subjects, but merely with the wish of showing how beneficial our inquiries may prove when thus connected, I will endeavour to ascertain the proper strata of some of the fossils mentioned in this work. To perform even this, I must avail myself of the observations made by the gentleman above mentioned, and by Mr. John Farey,

author of several excellent essays on stratification. To Mr. Farey I acknowledge considerable obligations for his exceedingly liberal and unreserved communications on subjects connected with these inquiries.

According to the actual observations of Mr. Smith, as given by Mr. Farey, in his General View of the Agriculture and Minerals of Derbyshire, Vol. I. p. 111, the following are the upper strata which have been discovered in this island, disposed in the order in which they occur.

1. Sand.
2. Clay, with septaria.
3. Sand, with shells, varying in thickness, and in mixture with other substances.
4. Soft chalk, with flinty nodules.
5. Hard chalk.
6. Chalk marl.
7. Aylesbury limestone.
8. Sand and clay strata, in one of which is a dark-coloured shelly limestone, called Sussex marble.
9. Woburn sand, in which is a stratum of fuller's earth.
10. A thick clay, called the clunch clay.
11. Bedford limestone.
12. A thick clay.
13. Rag-stone of Barnack, &c.
14. Limestone and grey slate of Stunsfield, Colley Water, &c.
15. Sand.
16. Bath free-stone.
17. Sand and clays.
18. Maidwell limestone.
19. Lias clay, containing the blue and white Lias limestone.
20. Sand.
21. Red marl.

Beneath these follow the grit-stones and coal shales, and the alternating limestones and toadstones. Parts of these inferior strata appear

to have been so raised and so denudated of their superincumbent strata, by some astonishing power, in Derbyshire, Staffordshire, and other adjacent counties, as to give the opportunity of examining the out-crop, or appearance on the surface, of these strata, which were originally covered by all the strata which have been enumerated above. The last discovered, entrochal, limestone of Derbyshire, must have originally lain, according to Mr. Farey's calculation, three miles perpendicularly lower than the upper part of the chalk strata.

Previously to considering more particularly the superior strata, it is necessary to make a few remarks on these strata of COAL and of limestone, which appear originally to have existed at such considerable depths. The coal measures, according to the observations of Mr. Farey, when found at or near the surface, are in situations in which, by the agency of that unknown power just alluded to, the strata which had lain over them has been removed*. Coal, as I have already endeavoured to show, appears to be the product of vegetable matter, buried under particular circumstances, as is almost proved by the simple fact of the traces of vegetables being almost constantly discoverable in it, and in its accompanying strata. If this opinion be correct, coal may then have been formed at any period since the creation of vegetables; and of course it would be improper to confine its origin, as is done in the first of these volumes, to that period at which the deluge occurred which is spoken of by Moses. The observations of Werner support this opinion, he having ascertained the formation of coal to have taken place at different periods, from that formation which rests on the granite rock, and is accompanied by prophyry and greenstone, to that of bituminous wood, peat, &c.

* Similar instances of this abstraction of the superior strata which has been observed by Mr. Farey, in Derbyshire, have been also discovered by Dr. Richardson, in the basaltic country in the counties of Derry and Antrim. Mr. Farey denominates these exposures of the inferior strata, *denudations;* and Dr. Richardson those removals of the superior strata, *abruptions.*—*Phil. Trans.* 1808.

The ENTROCHAL LIMESTONES of Derbyshire, &c. have their antiquity manifested by their original deep situation, and by the peculiar fossils which they contain. These are the *entrochi* and other *encrinal remains*, so much dwelt on in the second of these volumes. With these remains of different species of encrini, these limestones are in some parts, and to a very wide extent, entirely filled. In the limestone of Dudley, in Worcestershire, they are accompanied by a *tubiporites* (the chain-coral), and some beautiful minute *flustritæ* and *milleporitæ*, none of which, any more than the *encrinus* itself, are ever seen in any of the superincumbent strata. Of this animal, indeed, it may, I believe, be said decidedly, that it must have been lost ever since the formation of these very ancient strata.

Respecting the stratification of Bradford, near Bath, where we have seen that the *pear encrinite*, Vol. II. p. 208, has been so plentifully found, I have no authority to speak decidedly: I have, however, little doubt, that it would be found to be a portion of a lifted stratum, whose original situation was beneath the blue Lias. As has been just observed respecting the Derbyshire species, so it may be here observed, that no remains of this species have been found in any of the superior strata. Nor has any recent animal been found that could be placed in the same genus with the animals to which these remains belonged.

Above these strata are those of the alternating COAL SHALES and GRIT-STONES; and on these is disposed a stratum of RED MARL. Over this is a stratum of SAND; but neither in this nor the preceding stratum does it appear that any fossils have been noticed.

The LIAS CLAY is the next superior stratum, and contains beds of limestone called the BLUE and the WHITE LIAS LIMESTONE. This stratum has its continuity most decidedly evinced; it appearing on the coast of Dorsetshire, and ranging through the island, is again seen on the northern coast.

The fossils of this stratum are exceedingly numerous, and some of

them are again seen in some of the superior strata: but the characters of the greater part are such as to point them out decidedly as peculiar to this stratum.

In this stratum the fossil shells are exceedingly numerous: particularly *ammonitæ, nautilitæ, terebratulitæ, gryphitæ, mytulitæ, modiolitæ, spondylitæ, trigonitæ, belemnitæ,* and the large *donax-formed bivalve* mentioned p. 182. In this stratum are also found *fish of an unknown genus, with large square scales,* Pl. XVIII. Fig. 9, and several species of *Testudo, Lacerta,* &c.

It is to this stratum that the *pentacrinitæ* seem particularly to belong. These fossil remains occur with great frequency on the Dorsetshire coast. When the vertebræ of this animal appear in any of the superior strata, it is most probable, that they are alluvial, having been washed out of the raised or basseting edges of this stratum, by that ocean which deposited the stratum in which they are found. The confinement of the remains of this genus of animals to so low a stratum, is very extraordinary, since we have seen, that animals of this genus exist in the present ocean.

Immediately above this stratum is a blue marl-stone, called the MAIDWELL LIMESTONE, with the fossils of which I am unacquainted. Nor am I able to speak with more information of a great number and thickness of SANDS and CLAYS which lie over the Maidwell limestone.

To these succeed the BATH FREE-STONE strata, which may be traced in their range through the island. The upper part is a white or light grey limestone; beneath which is the *oolithe,* or *row-stone,* and under this a considerable thickness of *very light-coloured free-stone,* then *sand* and *clays,* and a *free-stone of various hues of yellow and red.*

The fossils of this strata are chiefly bivalve shells, of which generally only the casts, or the impressions remain. The casts are chiefly of *arks, bucarditæ,* (of Plott) a shell whose genus is not yet known, *trigonitæ, mytulitæ,* and various other bivalves, the casts or impres-

sions of which only remaining, the genus of the shell cannot always be determined. Among the more perfectly preserved bivalves are several *terebratulitæ*, particularly the shell whose curious internal structure is figured Pl. XVI. Fig. 11 and 13, and which has been also mentioned and figured by Mr. Walcott in his descriptions, &c. of the petrifactions found near Bath, p. 22, Fig. 33. To this stratum I believe the *patellitæ* of Gloucestershire belong, and in different parts of the stratum are found *belemnitæ.*

Above these is a SAND STRATUM, and in this is the LIMESTONE and GREY SLATE STRATA of Stunsfield, Colley Weston, Chippenham, &c. In this stratum, the *discoidal echinitæ* abound, as well as the *trigonitæ* and *belemnitæ.* In this strata are also found *pinnitæ*, *crenatulitæ*, and the *flat fossil oyster.* But the fossils which are here most abundant are the *bufonitæ*, and other parts of the *palates* and the *teeth of fishes.*

On these strata lies the RAG-STONE, which has been employed for most of the ancient well-preserved buildings in the eastern part of the island. This stone is formed of small bivalves, chiefly *anomitæ.*

Above this is a thick clay, on which is the limestone, called the BEDFORD LIMESTONE; in which are found small *gryphitæ*, *belemnitæ*, *ostreitæ*, *pectinitæ*, minute *crenatulitæ*, *pinnitæ*, a few *trigonitæ*, the uncommonly-marked bivalve Pl. XIII. Fig. 16, and various other shells.

Immediately over this is a stratum of clay called CLUNCH CLAY, from the beds of clunch, a soft chalk-like stone, which is found towards the top of it. *Ammonitæ*, large *gryphitæ*, *belemnitæ*, and various bivalves are found in this stratum.

Above this is the WOBURN SAND, containing in its lower parts fragments of silicified wood. To this succeed several sand strata and clays, and in one of these a thin bed of the shelly limestone called Sussex marble. Above this is the Aylesbury limestone, containing large *ammonitæ*, *gryphitæ*, &c.

Over this is disposed the CHALK MARL. The lower or HARD CHALK rests on the chalk marl, and acquires in different parts different degrees

of hardness, forming in some places a *white free-stone*, and in others a *softer fire-stone*. This stratum affords striking instances of the fact, first noticed by Mr. Smith, of *certain organic remains being peculiar to, and only found lodged in, particular strata*. The chief fossils which are found in this stratum are *ammonitæ* of a tolerably large size; and a *smaller species of an oval form*, different from those found in any other strata, Vol. III. Pl. IX. Fig. 6. Having obtained a specimen of this species from Steyning in Sussex, and knowing that the stratum of hard chalk was worked near Heytesbury in Wiltshire, I wrote to my late respected friend, Mr. Cunnington, to inquire if these fossils were found there or not; and I was agreeably surprised at receiving of him, from that stratum, an oval *ammonite* of the same species with that which I had found at Steyning. In this stratum are also found the remains of *scaphitæ*, Vol. III. Pl. X. Fig. 10*.

Immediately on this stratum is placed that of the SOFT CHALK, containing silex in the state of sand with interposed layers, and large interspersed, and irregular nodules of black flint. The fossils of this stratum differ in a very remarkable degree from those of all the inferior strata. Here are, I believe, never found *ammonitæ, trigonitæ, or scaphitæ*, which were found in the preceding stratum. The fossil remains which are here found are of *echinatæ* of different species, particularly of *cidaris, galea, galeola and spatangus;* here are also found *stellitæ, terebratulitæ, serpulitæ, ostreitæ, belemitæ*, a thorny *pectenites*, turbinated and other *madreporitæ*. The remarkable *limpet-like shell*, p. 51, Pl. V. Fig. 3. of the present volume, which is seen I believe in no other stratum; *teeth*, and rarely the *scales and bones of*

* The specimen, Pl. XVIII. Fig. 4, is very interesting from its showing the peculiar nature of the fossils of this stratum. It was found in the upper part of the Sussex hard chalk. It has very much the appearance of an echinital spine; but the smaller end is split into several rugæ: and in another specimen, not in other respects so perfect, it is seen, that this rugous termination was an organ of attachment, the fossil being thereby attached to a piece of shell. On this account, there appears to be reason for supposing it to be part of a shell of the same genus with the fossil represented Pl. VII. Fig. 18, of this volume.

fishes. I believe, in this stratum alone, occur the remains of those small animals figured in Vol. II. Pl. XIII. Fig. 24, 31, 34, 38, and 39, and which from several of their characters seem to deserve to be regarded as belonging to the family of *encrinites*.

On this chalk is deposited a thick stratum of WHITE SAND, over which is a sand of a darker colour, and above this various thin strata, or patches, of MARL, SHELLS, SANDSTONE, COARSE LIMESTONE, FRAGMENTS OF SHELLS, PEBBLES, &c. The sand, and several of these strata, exist in the neighbourhood of Woolwich, and may be distinctly traced through different parts of Kent; but do not appear to have been examined in the other parts of the island. The shells of these strata are chiefly of the genera *calyptræa*, *cerithium*, *pleurotomia*, *natica*, and *cyclas*; but from their fragile and mutilated state, many of the species, or even genera, cannot be made out. In these shells a considerable approach is observable to the shells of the present ocean.

Above this is the stratum of CLAY, employed round the metropolis for brick and tile making, containing *septaria* of different sizes, lying horizontally in parallel lines. In this stratum are found *pleurotomitæ*, *cerithitæ*, similar to those of the preceding stratum, the shells figured by Brander, as Hampshire fossils, *nautilitæ*, an immense number of *fruits*, *fossil wood*, and the numerous other remains noticed by Jacobs and others as Shepey fossils. Similar fossils with those obtained at Shepey, and in Hampshire, have been also found in this stratum, at Kew and at Highgate. At the latter of these places, and at Shepey, a *resinous substance* has been also found, which yields, on friction, a peculiar aromatic odour.

At Walton, near Harwich, as has been already noticed, the remains of several quadrupeds have been found. There have been obtained the remains of the *elephant*, *rhinoceros*, *Irish fossil elk*, *hippopotamus*, *ox*, *stag*, &c. Those which I found myself were on the beach, and the others I had been taught to suppose had been dug out of the blue clay. This, however, I have been led to doubt from the kind communica-

tions of the late Mr. William Trimmer. This gentleman ascertained that the bones of the *elephant*, *hippopotamus*, &c. found at Kew, were imbedded beneath sandy gravel, on a BED OF CALCAREOUS EARTH, from one foot to nine feet in thickness; that these remains were not found in any parts to which this calcareous stratum did not extend; and that a few feet of sandy gravel separated this bed from the stratum of blue clay. It appears, from the matter contained in the cavities of the Essex fossil bones, and from the colour of their substance, that they have lain in a similar bed. This also appears to have been the case with bones of the elephant and teeth of the rhinoceros, from Warwickshire and Gloucestershire. Hence it appears, that these animals lived on the dry land left by the departure of the waters which constituted the ocean, from which the clay stratum was deposited; and that they were overwhelmed by the deposition from the waters which formed the gravel stratum.

This deposition, which lies over the blue clay, is formed of strata, or of patches, of SANDY GRAVEL and SANDY CLAY; and at Walton and Harwich, in Essex, and in Suffolk and Norfolk, it contains numerous *fossil shells*, many of which are similar to those of the present day. With these fossil shells are also found fragments of *fossil bones*, which there is some reason for supposing may have belonged to the *mammoth*, or *mastodon*. Patches of roundish pebbles, doubtlessly formed at the bottom of a sea, exist in great quantities in extensive patches over this stratum of clay.

Even from this slight and imperfect sketch, it appears that the formation of the exterior part of this globe, and the creation of its several inhabitants, must have been the work of a vast length of time, and must have been effected at several distant periods.

In the first of these periods, the granitic and other primary rocks were separated from the water.* That this separation took place, as is stated in the scriptural record, previous to the creation of vege-

* Genesis i. 9.

tables and animals, is evident, from no remains of any organized substance having been ever found in any of these substances.

In the next period we are informed, by Scripture, that the creation of vegetables took place.* Almost every circumstance in the situation and disposition of coal accords with this order of creation; excepting that in many of the coal measures, the alternating limestones are full of the remains of shells. But, on the other hand, it must be observed, that as the formation of coal may have taken place soon after the creation of vegetables, and have continued even to a very late period, so, consequently, the accompanying strata may vary materially as to their contents. In the later formation, the remains of marine animals may be expected to be met with; but in the earliest formation, that which is found on granite, and accompanied by porphyry, greenstone, &c. it is probable that no remains of animals would be found, and fair proof would be yielded of an accordance, in this instance, between the order of creation as related by Moses, and the order in which the investing strata of the earth are disposed.

The creation of the succeeding period, according io the scriptural relation, was that of the inhabitants of the water and of the air.† In agreement with this order of creation, are the contents of all the numerous strata lying above those already mentioned; including the blue clay which we have seen disposed in many places almost at the surface. In all these strata no remains are to be found but those of the inhabitants of the waters; excepting those of birds, which exist, though rarely, in some particular spots. But in none of these strata has a single relic been met with which can be supposed to have belonged to any terrestrial animal.

In the next period it is stated, that the beasts of the earth, cattle, and every thing that creepeth upon the earth, were made.‡ The agreement of the situations in which the remains of land animals are found with this stated order of creation, is exceeding exact; since it

* Genesis i. 12. † Genesis i. 20. ‡ Genesis i. 24.

is only on the surface, or in some superficial stratum, or in comparatively some lately-formed deposition, that any remains of these animals are to be found.

The creation of man, we are informed, was the work of the last period : * and in agreement with his having been created after all the other inhabitants of the earth is the fact, that not a single decided fossil relic of man has been discovered.

This last circumstance will be considered by many as contradictory of the account of the Deluge, by which the earth, with man, was said to have been destroyed; since in the remains of the deluged world man might be expected to be found in subterraneous situations. The fact, however, is, that although no remains of man are found, the surface of the earth, which is inhabited by man, displays, even at the present day, manifest and decided marks of the mechanical agency of violent currents of water. Nor is there a single stratum of all those which have been mentioned, which does not exhibit undeniable proofs of its having been broken, and even dislocated, by some tremendous power, which has acted with considerable violence on this planet, since the deposition of the strata of even the latest formation.

From the whole of this examination a pleasing, and perhaps unexpected accordance appears between the order in which, according to the scriptural account, creation was accomplished, and the order in which the fossil remains of creation are found deposited in the superficial layers of the earth. So close, indeed, is this agreement, that the Mosaic account is thereby confirmed in every respect, except as to the age of the world, and the distance of time between the completion of different parts of the creation. These, in consequence of the literal acceptation of the word *day*, in that account, are reckoned to be much less than what every examination of the earth's structure authorizes their being supposed. If we are constrained to receive this word as descriptive of that length of time in which this planet now

* Genesis i. 26.

performs its diurnal revolution ; and are to consider the words morning and evening, applied to a time when the sun is said not to have been formed, as bearing the same meaning which they now convey, it must be acknowledged that the stumbling-block is immoveable. But if, on the other hand, the word day be admitted as figuratively designating certain indefinite periods, in which particular parts of the great work of creation were accomplished, no difficulty will then remain. The age of the world, according to the scriptural account, will then agree with that which is manifested by the phenomena of its stratification.

I am aware, that I shall obtain very little support in such a change from the critical expositors of this part of scriptural history, even should I plead, that in the poetical language of the prophets this word is sometimes thus used. I, however, trust, that I shall have produced no slight authority in its favour, if I show you that Moses himself employs this word in this sense, when speaking of *the whole creation of the heavens and the earth, and all the host of them.* "These," he says, "are the generations of the heavens and the earth, when they were created, in *the day* that the Lord God made the earth and the heavens*."

It is not necessary to proceed any further on this subject : it is, however, fair to state, that I did not commence the inquiries contained in these volumes without being forewarned of the great probability, that they would terminate in the establishing of certain facts, which might materially contradict the Mosaic account of the creation. This, however, instead of checking, served only to promote the investigation ; it being concluded, that if this were made with a due attention to impartiality, truth would be the result, and a fair criterion, by which the authority of this account might in some measure be judged, would be produced. Unapprised of what would be the termination of this inquiry, I resolved to prosecute it with fairness ; to shrink from no question, on account of its supposed tenderness ; and to conceal no conclusion, however repugnant to popular opinion or prejudice. That the

* Genesis ii. 4.

result should be so strongly confirmatory of the Mosaic account, I acknowledge was unexpected; and that so close an agreement should be found of the order of creation, as stated in Scripture, with the actual appearances of the depth of stratification which has been examined in modern times, must satisfy or surprise every one—Moses could not have learned this accordance from the Egyptians.

But leaving this subject to be examined by those whose extensive knowledge will enable them to form a more correct judgment on these points, I will only remark, that supposing the creation to have been performed in the order related in Genesis, and at particular periods, as is there stated, it becomes only necessary to consider these periods as occurring at considerable indefinite lengths of time, to prove an exact agreement between that particular history and those phenomena which appear on examining the stratification of the earth. But quitting conjecture, I shall conclude with placing before you a recapitulation of the more important of those phenomena, which seem to demand more particular attention.

I. The outer part of this globe, examined to as great a depth as circumstances have permitted, appears to be formed of numerous strata differing from each other in their composition, many of them containing remains of organized bodies, and all of them appearing to have been formed by deposition from water.

II. These strata, which appear once to have been continuous, have been broken through their whole depth, and so dislocated, that some masses of the lower strata now form considerable elevations on the surface, and in many of these the superior strata are carried away.

III. *Coal*, and traces of *vegetables*, with some particular marine animals, are found in the lowest strata that have been yet examined. In the other strata, up to the surface, the remains of the inhabitants of the water only are met with. Near to, and

on the surface, only, are found the fossil remains of various land-animals; but, no where have yet been discovered any fossil remains of man.

IV. In some of the earlier strata, the ENTROCHAL LIMESTONE, the remains of animals are found, the *cap* and *turban encrinite*, &c. but no similar fossils are seen in any of the succeeding superior strata, nor are any similar animals found in our present seas.

V. Some species of fossil animals *(pentacrinitæ)* occur in the LIAS, and are not, I believe, seen in any of the succeeding superior strata, but a recent similar animal is found in our present seas.

VI. Some fossil animals *(ammonitæ)* are first seen in the LIAS, and appear in most of the succeeding strata; but appear to have become extinct in the ocean which deposited the hard chalk.

VII. Some fossils *(belemnitæ)* appear in the early strata, and are continued upwards to the SOFT CHALK stratum, after which they are not seen.

VIII. Some fossils *(oval ammonitæ, scaphitæ, &c.)* are not known in the early strata, but occur in the HARD CHALK, and are not seen afterwards: as if they had been created at a comparatively late period, and had been soon afterwards suffered to become extinct.

IX. Some fossil shells *(trigonitæ)* are found in the LIAS and in MOST OF THE SUCCEEDING STRATA, and sometimes, but very rarely, in the hard chalk. After this they are not seen in the remaining superior strata, but of late years one species has been found in our present seas. This, however, requires some explanation. The *trigonitæ* are shells differing materially from any others in the structure of the hinge, and obtain therefrom the most decided generic characters. Until lately no shell of this genus was known in a recent state: one, however, has been found by M. Peron, in the South Seas; but this shell, although really of this genus, is of a different species from any

shell, which has been found in a fossil state. So that none of the species of shells of this genus, which are known in a fossil state, have, in fact, been found in any stratum above the hard chalk, or in our present seas.

X. In the SAND and in the BLUE CLAY above the chalk, many species of shells occur, of which not one is to be seen in the preceding strata; but of which several approximate to those in the present seas.

XI. In the GRAVEL, lying on the blue clay, *shells* are found, which differ from those of any of the preceding strata, and nearly agree with our recent shells.

XII. In these UPPER and LESS ANCIENT STRATA are found the fossil remains of *land animals;* and on this surface, which bears the marks of considerable torrents, are disposed, at least in this island, the present inhabitants.

Does it not appear from this repeated occurrence of new beings, from the late appearance of the remains of land animals, and from the total absence of the fossil remains of man, that the creative power, as far as respects this planet, has been exercised, continually, or at distant periods, and with increasing excellence, in its objects, to a comparatively late period: the last and highest work appearing to be *man*, whose remains have not yet been numbered among the subjects of the mineral kingdom?

FINIS.

LEICESTER:
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TO THE THIRD VOLUME.

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7. } mined.

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Pl. 1.

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Fig. 8. Another fossil shell, of an unknown genus; possessing characters both of nautilus and ammonites.
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Pl. XIII

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**

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PLATE XVI.

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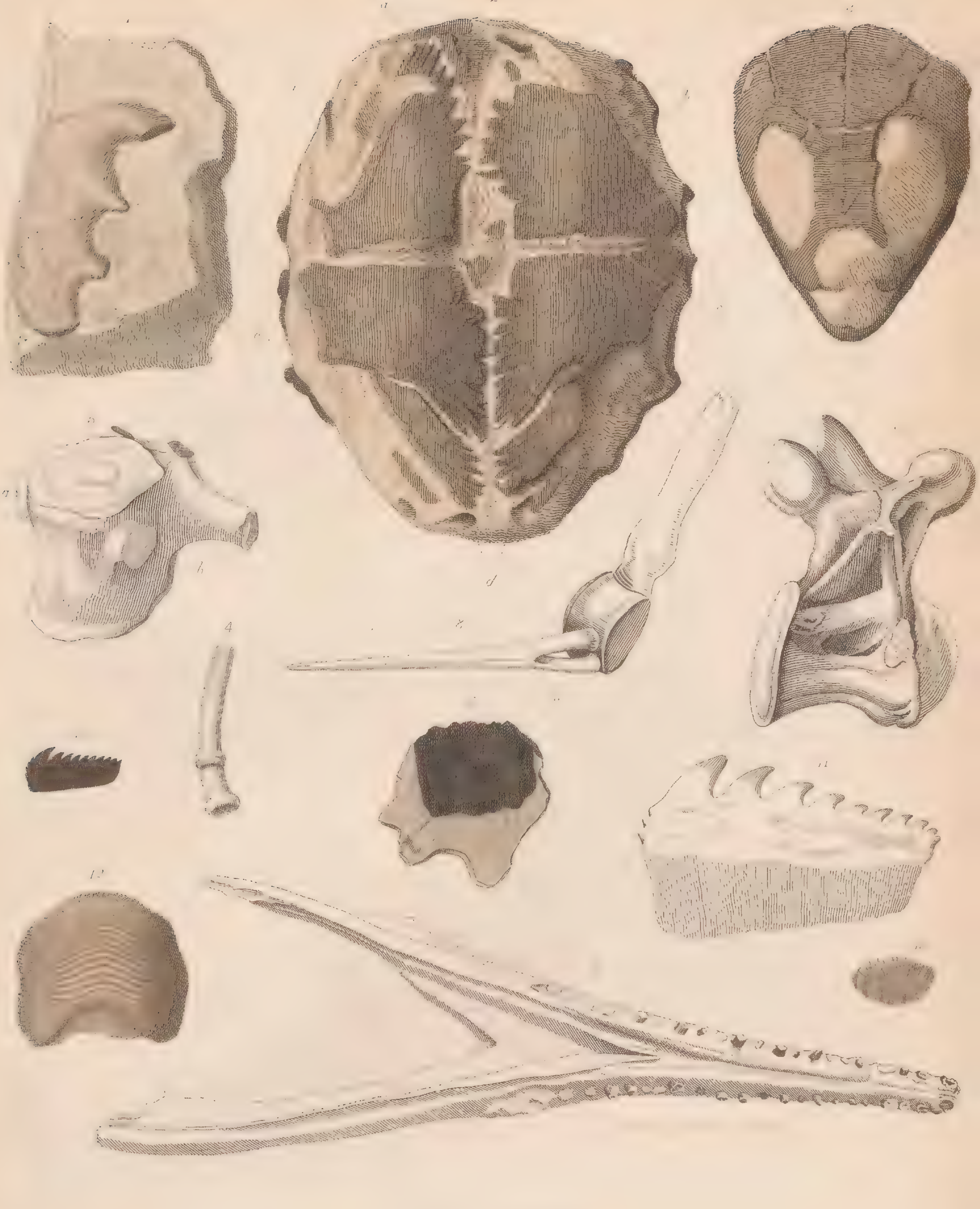

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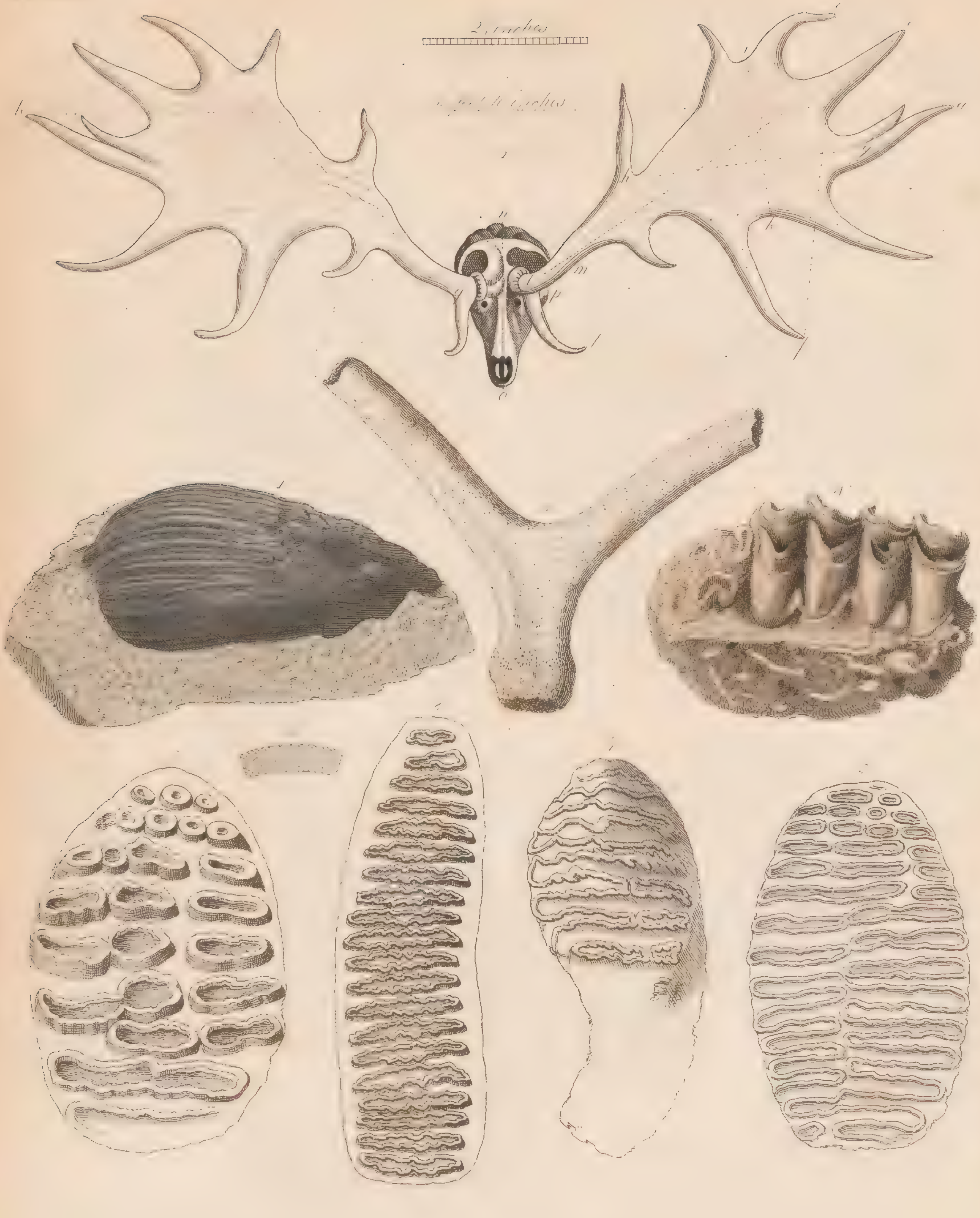

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Fig. 10. A small fossil tooth resembling, in form, the following.
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10. A fossil tooth of a fish longitudinally striated.
11. Fossil tooth, resembling that of the shark in form.
12. Two *Bufonitæ* attached to their bony processes.
13. A recent preparation illustrative of Fig. 16. and 17.
14. A fossil palate of a fish from Shepey.
15. *Palatum limax*, a body like a slug or leech, being part of a fish's palate.
16. A fossil palate or tongue of a fish of the ray kind from Shepey.
17. Nearly the same as the preceding.
18. A fossil body with a sharp rugous surface, having been part of a fish's palate.

PLATE XX.

Fig. 1. The horns of the fossil elk of Ireland.
2. A fossil tooth, perhaps of some animal of the whale kind.
3. A fossil horn about half its original size from Etampes.

Fig. 4. Part of a jaw of some ruminant in the calcareous mass of the Gibraltar rock.
5. A fossil elephant's tooth, with plates in an undulating form.
6. A fossil elephant's tooth, remarkable for the thickness of its plates.
7. A fossil elephant's tooth, remarkable for the disposition of its plates.
8. A fossil elephant's tooth, in which twenty plates exist in the length of six inches and a half.
9. A fragment of a fossil tusk, showing its structure.

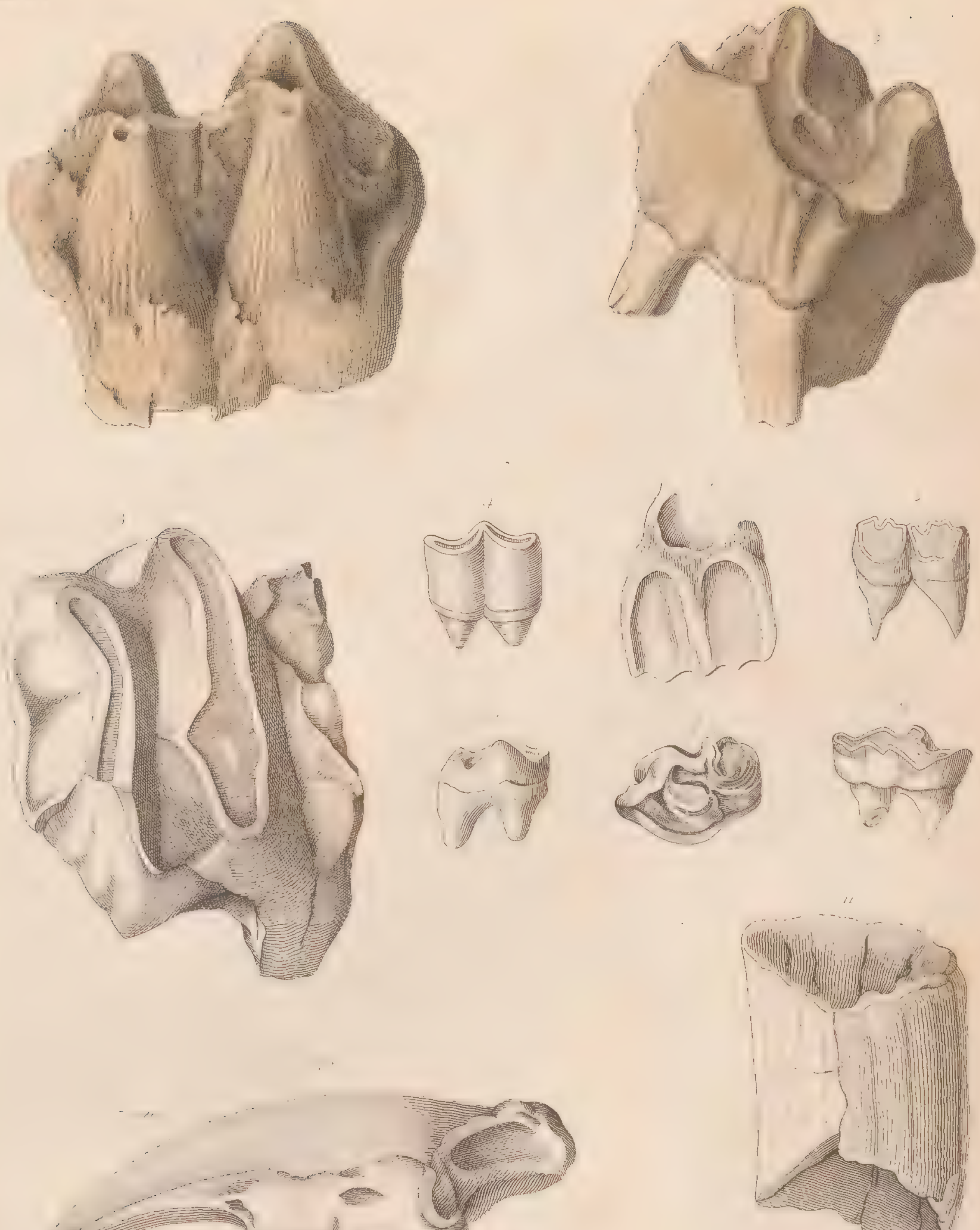
PLATE XXI.

Fig. 1. A fossil molar tooth of the hippopotamus of the right side of the lower jaw, and which has not long pierced the gums.
2. A fossil upper molar tooth of the rhinoceros.
3. A fossil tooth of the tapir.
4. The outer surface of the fourth molar tooth of the lower jaw of *Palæotherium medium*.
5. The inner surface.
6. The outer surface of one of the molares of the upper jaw.
7. The inner surface.
8. The antepenultimate lower grinder of the *Anoplotherium*.
9. The grinder which stands before the one Fig. 8.
10. The fossil claw-bone of the *Megalonix;* half the natural size.
11. A fossil tooth of the *Megalonix*.

PLATE XXII.

Fig. 1. Skeleton of theMegatherium.
2. The hindmost grinder of the upper jaw of the fossil bear of the caverns.
3 The middle upper grinder.
4. The foremost upper grinder.
5. The hindmost grinder of the lower jaw.
6. The penultimate grinder of the lower jaw.
7. The antepenultimate lower grinder.
8. The foremost lower grinder.
9. The canine tooth of the fossil bear.

PL. XVI



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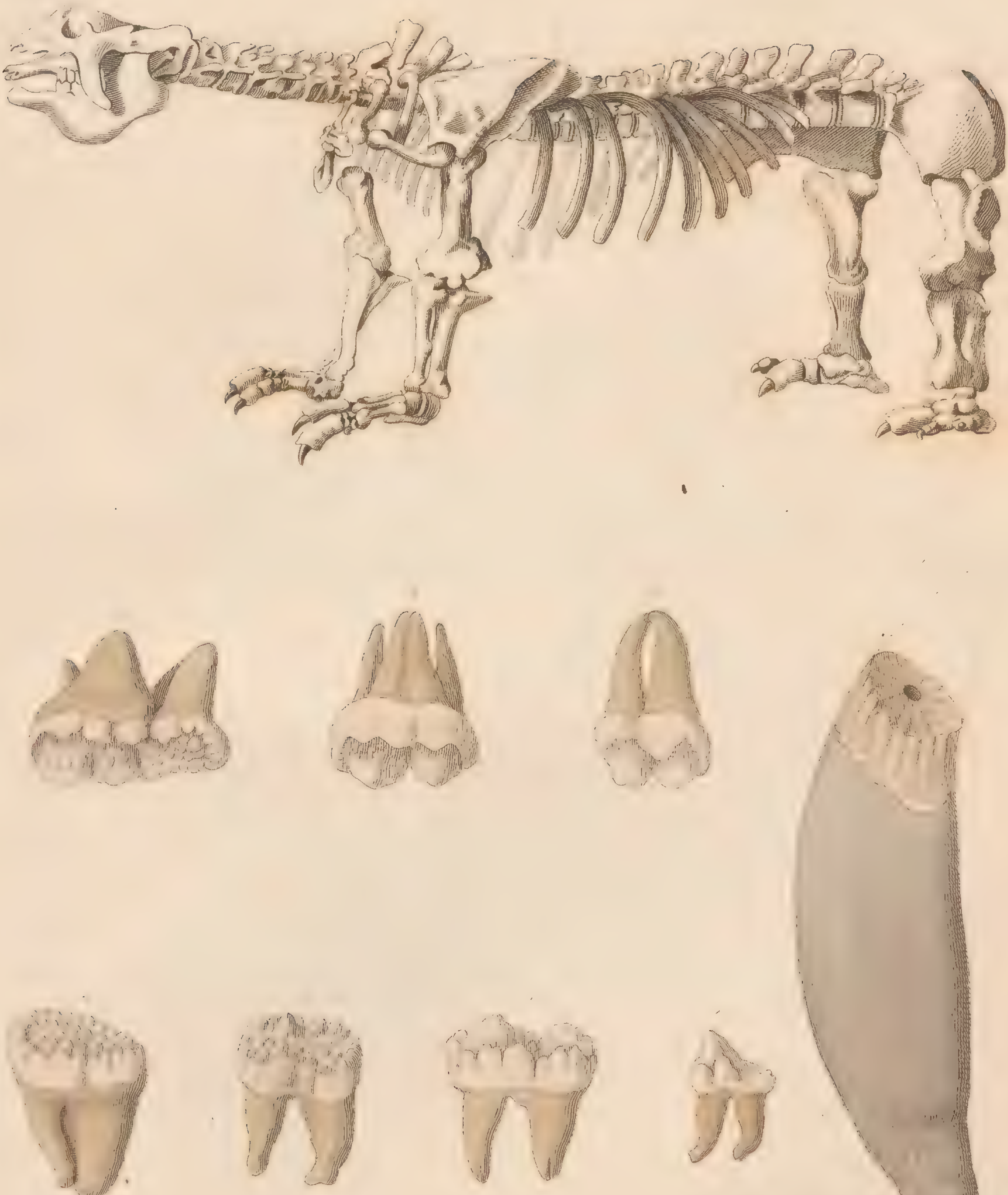
Pl. XXII



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275. On the species of animals to which the fossil bones belonged which are dispersed through the plaster-stone in the neighbourhood of Paris. Restitution of the head (*Palæotherium* and *Anoplotherium*).
364. Examination of the teeth, &c.
442. Restitution of the feet.
IV. 66. The bones of the trunk.
V. 52. Additions and corrections to the Memoir on the fossil *Tapir*.
99. Fossil remains of the *Hippopotamus*.
277. Skeleton of an animal of the genus *Sarigue*.
358. On the *Megalonix*.
376. On the *Megatherium*.
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249. }
270. On the great *Mastodon*.
401. On different teeth of smaller species of the genus *Mastodon*.
420. Recapitulation of the history of the fossil bones of *Pachydermata* found in loose and alluvial beds.
IX. 10. The fossil bones of the environs of Paris. The *Phalanges*.
16. The bones of the extremities.
89. The long bones of the fore extremities.
205. The scapulæ and pelves.
X. 210. On the bones of some carnivorous animals found in the plaster quarries in the environs of Paris.
XI. 272. Description of two nearly entire skeletons of the common *Anoplotherium*.
336. On the bones of birds found in the plaster quarries near Paris.
428. On the species of carnivorous animals, the bones of which are found mixed with those of *Bears* in the caverns of Germany and Hungary.
XII. 73. On the fossil bones of *Crocodiles*, and particularly of those of the neighbourhood of Havre and Honfleur, with remarks on the skeletons of some of the lizard tribe from Thuringia.
145. On the large fossil animal of the quarries of Maestricht.
271. On the fossil bones of the environs of Paris.
332. On the fossil bones of *Ruminants*.
XIII. 169. On the *Osseous Brecciæ* of Gibraltar, &c.

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	383.	Emarginula, Calyptræa, Conus, Cypræa, Terebellum, Oliva.
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II.	57.	Mitra, Marginella, Cancellaria, Purpura.
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